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TRANSACTIONS

OF THE

AMERICAN OTOLOGICAL SOCIETY

1908-1909.

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PARTS 1 AND 2.

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FORTY-FIRST ANNUAL MEETING.

HOTEL CHELSEA,

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DANIEL BENNETT ST. JOHN ROOSA.

In Memoriam.

On February 10th, in New York City, so long the scene of his valuable labors, died Dr. Roosa, ex-President of the American Otological Society and a most important contributor to the advance of Aural Surgery. Born in Bethel, N. Y., April 4th, 1838, of Dutch lineage, he was educated in Boston and New York and received his medical degree from the University of the City of New York in 1860. After a term as House Surgeon in the New York Hospital, he enlisted with the N. Y. 5th Regiment as Asst. Surgeon and later served with the N. Y. 13th. Settling in New York City about the close of the war, he devoted himself to eye and ear practice and received from his Alma Mater the Chair in these specialties, and a little later also that in the University of Vermont. In 1864 he translated and edited v. Troeltsch's "Text-book" and, after a second edition in 1869, published his own "Treatise on Diseases of the Ear" in 1873, which has gone through many editions and has now been replaced by "The Ear, Nose and Pharynx," published in 1905 in collaboration with Beaman Douglass. Many journal articles and addresses on otological and other subjects were supplimented by his "Treatise on the Eye" and the editing of other works. His most notable work was the founding with others of the New York Post-Graduate School

and Hospital in 1882, when the University declined to afford the facilities for Post-Graduate teaching demanded by Roosa and his colleagues. He became the President of this first post-graduate school in America and remained at its head until his death, most of the time active upon its teaching staff; and it, as well as the whole cause of such teaching in America, owes much to his initiative and continued support.

Of strong dominant personality, full sonorous voice and forceful expression, he made himself felt in all affairs in which he took part; and in the International Otological Congress of 1888 in Brussells he was easily the most impressive of the English-speaking members. He presided over the First International Otological Congress when it met in New York in 1876, and has been on the Organization Committee of that Periodical Congress since.

HORACE GEORGE MILLER.

In Memoriam.

In the death of another ex-President, the American Otological Society has sustained a loss which its younger members may but partially appreciate, since the modest, unaggressive man who had been called to preside over many other societies besides this, made no effort to impress by frequent presentation of his ripe experience in paper or discussion. An able, learned practitioner, he promptly seized every new idea which his sound judgment com-

mended; but kindly giving credit to the authors who had furnished the suggestions which he generally enriched by his wise application of them, he ascribed to others the same alert acceptance of all that was good. Hence he never rushed into print to claim priority nor had to make public apology for advocating bubbles which soon burst. Yet the even tenor of his way was far from lacking in positive influence on those who came into contact with him and his quiet force as one of the most constant in attendance at our meetings will be indirectly felt in the future through many upon whom his impress has been unobtrusively made.

Graduated from Brown University in 1860, he was one of the earliest members of our Society, which he joined soon after his graduation from Harvard in 1865, and he held until his recent retirement from practice the foremost position in Providence as a specialist in eye and ear surgery. As a medical man in general he was hardly less prominent, as witness his Presidency of the Rhode Island Medical Society, the Brown University Medical Society and many similar organizations. He was connected with the principal hospitals of Providence and had been President of the New England Ophthalmological Society; and after several years as our Vice President, he ably filled the chair of President of this Society from 1900 until 1902. Cataract added to the burden of impaired health which had hampered his work, and although this was successfully removed, he did not resume his practice. He died in his summer home in Camden, Maine, on May 29th, of this year; and all who had tasted the warm hospitality of Dr. Miller and his devoted wife join in mourning the loss from our ranks of a genuine scholar and gentleman.

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Dr. Thomas R. Pooley	107 Madison Ave.	New York, N. Y.
Dr. Barton H. Potts*	109 South 20th St.	Philadelphia, Pa.
Dr. John Broadfoot Rae*	616 Madison Ave.	New York, N. Y.
Dr. B. Alex Randall	1717 Locust St.	Philadelphia, Pa.
Dr. Wm. Rankin Jr.		
Dr. J. M. Ray	Suite 300, Atherton Bldg.	Louisville, Ky.
Dr. R. G. Reese*	147 West 57th St.	New York, N. Y.
Dr. R. A. Reeve	22 Shuter St. cor. Victoria	Toronto, Canada.
Dr. H. O. Reik	5 West Preston St.	Baltimore, Md.
Dr. W. Scott Renner*	361 Pearl St.	Buffalo, N. Y.
Dr. Geo. L. Richards	84 North Main St.	Fall River, Mass.
Dr. Huntington Richards	St. Paul's School	Concord, N. H.
Dr. John D. Richards*	44 West 49th St.	New York, N. Y.
Dr. Chas. W. Richardson	1317 Connecticut Ave.	Washington, D. C.
Dr. S. O. Richey	732 17th St.	Washington, D. C.
Dr. Charles E. Rider	53 South Fitzhugh St.	Rochester, N. Y.
Dr. Wheelock Rider	53 South Fitzhugh St.	Rochester, N. Y.
Dr. F. W. Ring		
Dr. H. W. Ring	187 Church St.	New Haven, Conn.
Dr. S. D. Risley	1738 Chestnut St.	Philadelphia, Pa.
Dr. Edmund C. Rivers*	1632 Welton St.	Denver, Col.
Dr. Wm. King Rogers	88 East State St.	Columbus, O.
Dr. D. B. St. John Roosa.		
Dr. John D. Rushmore	129 Montague St.	Brooklyn, N. Y.
Dr. Wm. W. Seely		
Dr. Ralph W. Seiss	255 South 17th St.	Philadelphia, Pa.
Dr. S. Sexton		
Dr. Geo. E. Shambaugh	100 State St.	Chicago, Ill.
Dr. J. B. Shapleigh	W. cor. Grand & Wash. aves.	St. Louis, Mo.
Dr. W. S. Shattuck, Jr.	*160 Clinton St.	Brooklyn, N. Y.
Dr. Henry L. Shaw	19 Commonwealth Ave.	Boston, Mass.
Dr. J. E. Sheppard	130 Montague St.	Brooklyn, N. Y.
Dr. E. Terry Smith*	75 Pratt St.	Hartford, Conn.
Dr. Sargent F. Snow*	707-713 University Block	Syracuse, N. Y.
Dr. E. D. Spear	Colonial Building 100 Boylston St.	Boston, Mass.
Dr. H. N. Spencer	2723 Washington Ave.	St. Louis, Mo.
Dr. Frank B. Sprague	27 Stewart St.	Providence, R. I.
Dr. Franklin M. Stephens*	71 West 49th St.	New York, N. Y.

DR. GEORGE T. STEVENS .22 East 46th St.....New York, N. Y. ..
DR. EDWARD STIEREN*...3603 Fifth Ave.....Pittsburg, Pa.....
DR. S. B. ST. JOHN.....68 Pratt St.....Hartford, Conn.....
DR. GEO. STRAWBRIDGE..202 South 15th St. .....Philadelphia, Pa....
DR. T. Y. SUTPHEN .....999 Broad St.....Newark, N. J. . ...
DR. L. H. TAYLOR .... .82 South Franklin St....Wilkes Barre, Pa...
DR. SAMUEL THEOBALD ..Cathederal & Howard Sts.Baltimore, Md. ....
DR. WILLIAM THOMSON ..1426 Walnut St.....Philadelphia, Pa....
Dr. Robert Tilley
DR. ANDREW TIMBERMAN*112 East Broad St.....Columbus, O. .....
DR. J. VANDUYN.....318 James St.....Syracuse, N. Y.....
Dr. J. J. B. Vermyne
DR. E. DEWOLF WALES* .320 North Meridian St..Indianapolis, Ind. ..
DR. D. HAROLD WALKER* 28 Newbury St.....Boston, Mass.....
DR. DAVID WEBSTER.....308 Madison Ave.....New York, N. Y. ..
DR. J. A. WHITE*.....200 East Franklin St....Richmond, Va.....
DR. F. WHITING.....47 West 50th St.....New York, N. Y. ..
DR. F. M. WILSON.....834 Myrtle Ave.....Bridgeport, Conn...
DR. HIRAM WOODS.....842 Park Ave. .....Baltimore, Md.....

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*Associates.

†Temporarily at Santa Barbara, California.

American Otological Society.

The Forty-first annual meeting of the American Otological Society was held at Hotel Chelsea, Atlantic City, New Jersey, June 23 and 24, 1908.

The following members were present:

DRS. T. P. BEHRENS.....New York, N. Y.
F. J. BLODGETT.....New York, N. Y.
W. SOHIER BRYANT.....New York, N. Y.
C. G. COAKLEY.....New York, N. Y.
E. A. CROCKETT.....Boston, Mass.
J. FRANK CROUCH.....Baltimore, Md.
J. P. DAVIDSON.....Richmond, Va.
E. W. DAY.....Pittsburg, Penn.
E. B. DENCH.....New York, N. Y.
ARTHUR B. DUEL.....New York, N. Y.
PERCY FRIDENBERG.....New York, N. Y.
HARRY FRIEDENWALD.....Baltimore, Md.
EMIL GRUENING.....New York, N. Y.
T. J. HARRIS.....New York, N. Y.
DAVID HARROWER, JR.....Worcester, Mass.
W. H. HASKINS.....New York, N. Y.
CHRISTIAN R. HOLMES.....Cincinnati, Ohio.
FREDERICK L. JACK.....Boston, Mass.
WALTER B. JOHNSON.....Paterson, N. J.
J. A. KENEFICK.....New York, N. Y.
B. R. KENNON.....Norfolk, Va.
CHARLES J. KIPP.....Newark, N. J.
D. BRADEN KYLE.....Philadelphia, Penn.
G. A. LELAND.....Boston, Mass.
ROBERT LEWIS, JR.....New York, N. Y.
WILLIAM LINCOLN.....Cleveland, Ohio.
DAVID B. LOVELL.....Worcester, Mass.
WENDELL C. PHILLIPS.....New York, N. Y.
NORVAL H. PIERCE.....Chicago, Ill.

BARTON H. POTTS.....Philadelphia, Penn.
B. ALEANDER RANDALL.....Philadelphia, Penn.
HENRY O. REIK.....Baltimore, Md.
W. SCOTT RENNER.....Buffalo, N. Y.
GEO. L. RICHARDS.....Fall River, Mass.
GEO. E. SHAMBAUGH.....Chicago, Ill.
WARREN S. SHATTUCK, JR.....Brooklyn, N. Y.
E. TERRY SMITH.....Hartford, Conn.
SARGENT F. SNOW.....Syracuse, N. Y.
FRANK B. SPRAGUE.....Providence, R. I.
FRANKLIN M. STEPHENS.....New York, N. Y.
HIRAM WOODS.....Baltimore, Md.

The meeting was called to order at 10 a. m. by the president, Dr. C. J. Kipp of Newark, N. J., who appointed as a Business Committee Drs. Crockett, Pierce and Reik.

The Treasurer's Report was read by Dr. Frederick L. Jack, and was referred to an auditing Committee.

The Chair appointed Dr. Shambaugh to act on the Membership Committee in place of Dr. Fiske, who was absent.

The secretary read a letter from Prof. Jansen of Berlin expressing his regrets at not being able to attend the meeting.

Dr. Randall called attention to the recent death of Dr. Horace J. Miller of Providence, and suggested that some minute of his death be prepared for the Transactions.

The Chair appointed Dr. Randall a Committee to draw up such minute.

The Secretary read a letter from Dr. J. Orne Green, presenting his resignation as a member of the Society.

On motion of Dr. Randall the resignation was accepted, Dr. Green's name to be transferred to the list of Honorary Members.

Dr. Norval H. Pierce, Chicago, read a paper on A Brief Historical Review of Operations for the Cure of Chronic Ear Suppuration.

Discussed by Dr. Emil Gruening, New York, and Dr. B. Alex. Randall, Philadelphia.

Dr. E. A. Crockett, Boston, read a paper on Report of a Case of Vertigo Relieved by Removal of the Stapes, with the Consideration of the Subject.

Discussed by Dr. Frederick L. Jack, Boston; Dr. Geo. E. Shambaugh, Chicago; Dr. Sargent F. Snow, Syracuse; Dr. A. B. Duel, New York; Dr. H. O. Reik, Baltimore; Dr. Norval H. Pierce, Chicago, and in closing by the Essayist.

Dr. Geo. E. Shambaugh, Chicago, read a paper on The Epithelium of the Sulcus Externus.

Afternoon Session, June 23, 1908.

The meeting was called to order at 2 p. m., Dr. Kipp, Newark, in the chair.

Dr. C. G. Coakley, New York, gave a Demonstration of Radiographs of the Temporal, Accessory Sinuses, etc.

The Society extended a vote of thanks to Dr. Coakley for his Demonstration.

The Nominating Committee reported as follows:

President—Dr. Frederick L. Jack, Boston.

Vice President—Dr. R. L. Reeve, Toronto.

Secretary-Treasurer—Dr. James F. McKernon, New York.

Membership Committee—Drs. Lewis, Friedenwald and Pierce.

Publication Committee—Drs. Blake, Shambaugh, and the Secretary.

The Report of the Nominating Committee was adopted and the Secretary was instructed to cast the ballot for the nominees.

The Business Committee recommended that a Committee of one from this Society be appointed to confer with a Committee from the Ophthalmological and American Laryngological Societies regarding the time and place of next meeting. They recommended that the three Societies meet on consecutive days in the same week and place if

possible; and, if not, arrangement be made with at least one of the Societies named in any event.

The recommendation was adopted.

In looking over the membership list, it had been found that it contained the names of many men who never appear at the meetings; the by-laws call for the members to appear and sign the roll at least every three years; they therefore recommended that the Secretary notify members that this rule will be enforced dating from the present meeting.

Dr. Gruening offered an amendment that this recommendation apply only to those who have not been members for twenty years or more. The amendment was accepted and the recommendation adopted.

The Auditing Committee reported the Treasurer's Report as examined and found correct.

Dr. Sargent F. Snow, Syracuse, read a paper on Further Mastoid Observations.

Discussed by Dr. B. Alex. Randall, Philadelphia; Dr. C. R. Holmes, Cincinnati; Dr. Emil Gruening, New York; Dr. H. O. Reik, Baltimore; Dr. Roberts, Pasadena; Dr. Hiram Woods, Baltimore; Dr. A. B. Duel, New York; Dr. T. J. Harris, New York; and in closing by the essayist.

Dr. G. A. Leland, Boston, read a paper on A Case of Double Otitis Media Purulenta with Extradural and Intradural Abscesses, Extensive Exploration of the Brain, Double Exenteration, Recovery with Good Hearing.

Dr. C. J. Kipp, Newark, read a paper on Report of a Case of Double Optic Neuritis and Bilateral Paralysis of the External Recti Muscles of the Eye, which developed after an Operation for Mastoiditis, during which the Lateral Sinus was twice wounded and was found to contain Fluid Blood; Complete Recovery.

Discussed by Dr. N. H. Pierce, Chicago; Dr. E. A. Crockett, Boston; Dr. G. A. Leland, Boston; Dr. Harry Friedenwald, Baltimore; Dr. Hiram Woods, Baltimore; and in closing by the essayist.

Morning Session, June 24, 1908.

The meeting was called to order, the Chairman, Dr. C. J. Kipp, Newark, presiding.

The Membership Committee reported as follows:—Your Committee in considering the names that have been submitted to them have been guided in their action by the following principles, which although not explicitly expressed in the Constitution, seem to be implied.

First: That the prospective member shall be in active practice of Otology for at least five years.

Second: That he shall have several letters of recommendation from members of the Society who are acquainted with him personally.

Third: That there shall accompany his application for membership evidences that he has the proper scientific attainments to fit him for the active work of the Society. This evidence may be in the form of a published or unpublished thesis.

In explanation of the above position your committee realize that this is the leading Society of Otologists in America, and that the standard must be correspondingly high. In adopting this standard we are placing the American Otological Society on the same basis as exists in other similar Societies.

In order that the Society may have a definite policy to guide future membership committees, your committee offers the following amendment to Section 2 of the Bylaws; after the phrase "Setting forth the claim of such candidates for membership," to read as follows:—That there shall accompany his application for membership evidence that he has the proper scientific attainments to fit him for the active work of the Society, this evidence may be in the form of a published, or unpublished thesis.

Of the names presented for Associate Membership the committee recommends the following: Dr. John D. Richards of New York and Dr. Ralph Butler, of Philadelphia.

The names of the following are upon the list of candidates to be acted upon at the next annual meeting, the majority of these names were presented with excellent letters of recommendations, but they had not met with the third requisite, as recommended in the above report.

Dr. J. B. Rae, of New York; Dr. John Dunn, of Richmond; Dr. H. S. Birkett, of Montreal; Dr. David Fiske, of Chicago; Dr. G. P. Pond, of San Francisco, and Dr. George H. Powers, of Boston.

You referred back to this committee for their further consideration the names of Dr. J. B. Rae, of New York; Dr. John Dunn, of Richmond; and Dr. H. S. Birkett, of Montreal. The committee having obtained further information regarding these men, are pleased to recommend them for Associate Membership.

Dr. Randall called for a vote on these recommendations and Dr. Reik asked for a ballot on each candidate.

Dr. Behrens was appointed teller and on conclusion of the balloting Drs. Birkett and Rae were declared elected.

On motion of Dr. Dench, seconded by Dr. Gruening, the name of Dr. Dunn was referred back to the Committee for action next year.

The Business Committee recommended as Delegate and Alternate respectively to the Congress of American Physicians, Drs. F. B. Loring and Samuel Theobald, which recommendation was adopted.

A motion by Dr. Randall to extend an invitation to the International Otological Society, at its meeting in Budapest, to hold its next meeting in America was carried, and the Chair appointed the same Committee, with power to fill any vacancy or increase their number as they might see fit.

Dr. Dench read a letter regarding the establishment of a Journal, asking the Society to act in co-operation with the Rhinological, Otological and Laryngological and American Laryngological Societies.

Dr. Woods moved that the matter be referred to a Committee with power to act, which was carried, and the Chair appointed Dr. Jack.

Demonstration of Instruments and Photographs: Dr. Wendell Phillips, New York, exhibited two photographs of a case of carcinoma of the ear which had been reported before at the New York Otological Society. The primary location of the disease was in the floor of the external canal. The photograph illustrated the present condition of a patient suffering from Epithelioma of the auricle. The patient had been exhibited at one of the meetings of the N. Y. Otological Society last winter with a narration of the history. The diagnosis had been verified by microscopic examination.

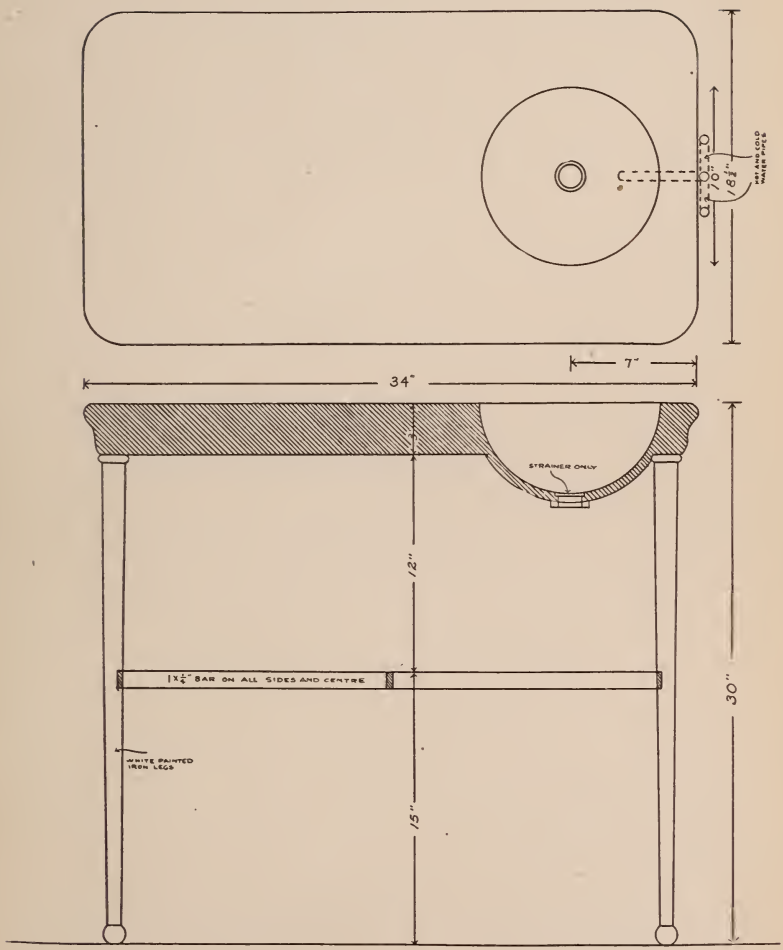
Dr. Phillips also exhibited a Suction Douche devised by Dr. Edmund Prince Fowler of the Manhattan Eye and Ear Hospital. He reported most favorable experience in the use of the instrument in treating cases of acute otitis media. It could also be used to produce hyperaemia and massage. Photographs were shown illustrating the method of using the instrument.

Dr. Sprague, Providence, exhibited an instrument for removing the malleus and incus, in the form of a little ring knife, an incus hook for removing the incus. Also an improved ice bag and nasal douche.

Dr. Smith exhibited a nasal speculum designed to be used with the left hand, leaving the right free to operate or use a probe.

Dr. Richards demonstrated a new tonsil forceps for use in dissecting out the faucial tonsils.

Dr. Walter B. Johnson, Paterson, presented a blue-print illustrating a treatment table. He said, "In presenting this drawing of a treatment table to be used in the treatment of diseases of the Eye, Ear and Throat in Hospitals and Dispensaries I do so because it seems so desirable that running water should be conveniently located upon the table. It is my intention to adopt such tables which are to be made for use in the new Infirmary building which is to be erected by the Paterson Eye and Ear Infirmary."



DRAWING FOR TREATMENT TABLES
FOR PATERSON EYE AND EAR INFIRMARY
M. HOUMAN ARCH'T. CENTRAL BUILDING PATERSON N

Presented by Dr. Walter B. Johnson.

Dr. Sargent F. Snow, Syracuse, presented a new paracentesis knife. The knife shown is simply the angular spear-pointed knife enlarged and strengthened so that the incision through the drum attic folds and along the canal wall may go to the bone.

Dr. Percy Fridenberg, New York, read a paper on The Non-Acoustic Function of the Inner Ear, which was discussed by Drs. Randall, Philadelphia; and Shambaugh, Chicago.

A Symposium was presented on Chronic Progressive Hardness of Hearing (Otosclerosis).

(a) Etiology, Dr. Thomas J. Harris, New York.

(b) Pathology and Prognosis, Dr. W. Sohier Bryant, New York.

(c) Symptoms and Diagnosis, Dr. G. E. Shambaugh, Chicago.

Discussed by Dr. E. B. Dench, New York; Dr. A. B. Duel, New York; Dr. N. H. Pierce, Chicago; Dr. B. Alex. Randall, Philadelphia.

Afternoon Session, June 24, 1908.

The meeting was called to order, Dr. C. J. Kipp, Newark, presiding.

Dr. Barton H. Potts, Philadelphia, read a paper on Non-Purulent Labyrinthitis as a Complication in Acute Middle Ear Suppuration.

Dr. B. Alex. Randall, Philadelphia, read a paper on A Case of Fatal Sepsis after Fracture of the Temporal and Occipital Bones.

Dr. Emil Gruening, New York, read a paper on A Case of Sinus Thrombosis.

Dr. E. B. Dench, New York, read a paper on A Case of Acute Suppuration of the Labyrinth Following Acute Otitis Media; Operation; Recovery.

Dr. G. L. Richards, Fall River, exhibited a specimen of a bullet which a man had shot into his own ear ten years before, followed by facial paralysis and total loss of hearing in that ear; subsequent improvement in the paralysis after removal of the bullet in a radical mastoid operation.

Discussed by Dr. N. H. Pierce, Chicago; Dr. F. L. Jack, Boston; and Dr. E. B. Dench, New York.

The Society then adjourned.

JAMES F. McKERNON,
Secretary.

SYMPOSIUM ON OTO-SCLEROSIS. THE ETIOLOGY OF OTO-SCLEROSIS.

By THOMAS J. HARRIS, M. D., New York, N. Y.

The Secretary is to be congratulated on putting a subject as important as this on the programme for discussion this year. It is my only regret that the duty of presenting the first paper in it should devolve on one so incompetent.

Twenty years ago we heard and read little upon this potent cause of deafness. The textbooks of that day mentioned a form of middle disease known as dry or hyperplastic catarrh but the impression was given that it was met with only infrequently and was of little significance compared with the common hypertrophic variety. Since that time otologists especially those abroad have busied themselves with the subject and an inspection of the literature of the past two decades will show many valuable contributions thereto. There is today in spite of all this, much unmerited ignorance and too often it is grouped clinically with the other non-suppurative affections of the middle ear. Any intelligent consideration of the causes of oto-sclerosis demands a clear understanding of the exact pathologic process which is producing the affection. This since Politzer's valuable paper, later reinforced by Siebemann's work, has commonly been held to be a rarefying process of the labyrinthine capsule or the region in the vicinity of the oval window either internal or external to it or both. This is regarded by Politzer to be a primary affection. That such a condition at times exists cannot be gainsaid as has been abundantly shown on the post-mortem table. That it is the usual condition in the cases which we are accustomed to regard clinically as otosclerosis, is however decidedly open to question. The

grounds for this radical departure from what has been a generally accepted position of all writers, are clearly set forth in Lucae's recent treatise on the subject, entitled Die Chronische Progressive Schwerhörigkeit.

Lucae calls attention to the fact that Von Troelsch was the first to make use of the term sclerosis and while the latter does not specifically mention it, he in all probability based his employment of the term on the careful description of a group of cases by Toynbee which he characterized as cases of **rigidity** of the **lining membrane** of the **ear.** Adopting Toynbee's idea of the pathology in such cases and defending his position at much length and by the citation of numerous cases of his own, Lucae maintains that a previous inflammatory condition either, the ordinary hypertrophic form or that of suppuration, is at the bottom of the great majority of all cases of sclerosis. Such a condition especially one of a transient suppuration occurring in childhood or infancy as it often does, can most easily be lost sight of at the period when the symptoms of the disease are first noted. Toynbee's description of these so-called cases of "rigidity" of the mucous membrane of the ear is deserving of being quoted in full. "The mucous membrane of the tympanum may be subject to chronic inflammation, complicated or not with rheumatism, at any period of life, and, if neglected, this is liable to terminate in a rigid state of the membrane, so that the ossicles become bound together more firmly than is natural. In advanced years, this rigid condition seems to take place without any symptom of inflammation. The membrana tympani also partakes of this rigid condition, and, what is of far greater importance, the base of the stapes may become much more firmly fixed to the border of the fenestra ovalis than is natural. As a consequence, the membrane of the fenestra rotunda and the fluid of the labyrinth participate in this fixed condition. This affection is less prevalent in the young than in the adult, in whom it is liable to occur after repeated attacks of cold, whether with pain or not.

It is, however, most frequent in persons advancing in life, and may, in fact, be considered as the disease which causes deafness in advancing years. The generally received opinion that in this kind of deafness the nervous system is at fault, is manifestly incorrect, as proved by the symptoms, and by the mode of relief found beneficial." In addition to this condition so clearly set forth, Toynbee describes two others giving rise to similar symptoms. I, **membranous bands in the tympanic cavity.** "These may arise in any part of the cavity connecting together the ossicles and attaching them to the walls of the tympanum and to the drum membrane." The stapes is wont to be bound down to the promontory and thus a species of anchylosis produced. Toynbee is of the opinion that these bands are the result of the effusion of fibrin from the membrane or from the adhesion together of the already hypertrophied membrane. II, the **second condition** is that of **anchylosis** of the **stapes**, so well known to all aurists since his day. In his opinion however this anchylosis permits of various gradations according to the stage of the disease. At first it is only partial without expansion of the base of the stapes, depending on a rigidity of the capsular ligaments. This is the earliest form. A second stage is the expansion of the articular surfaces without changes in the bone. This was found in 49 of the 136 specimens of anchylosis described in his catalogue. The later stages represent hypertrophy of the entire stapes base. Here it is often impossible to remove the crura from the oval window without breaking, and finally we may meet in the most advanced cases, actual deposit of bone.

These classical views of one of the earliest workers in our specialty, we have taken the liberty of quoting at some length because of their direct bearing on the question of etiology under consideration and because they serve without doubt as a basis for the views which have been set forth by Lucae in his recent book just referred to. Lucae is prepared to admit that a certain percentage of ear cases will fall in the group of primary disease of the labyrinthine capsule

but believes that careful inquiry as to a previous ear condition and the employment of the more accurate methods of diagnosis, will serve to greatly reduce the number. The opinion of so competent and experienced an observer is worthy of our most thoughtful consideration. While not prepared perhaps to subscribe to it at present in its entirety, we feel that it represents in the main a reasonable view of the subject, one that offers hope as far as prognosis is concerned where hope formerly could not be entertained and one entitled to be applied to all cases of this class which present themselves to us for treatment.

We would repeat then that in our opinion oto-sclerosis represents not one but several pathologic conditions. Viewed from this standpoint the question of cause or causes becomes a broad one. Inasmuch as there seems in the majority of cases to be a precedent middle catarrh, it may be said that the same causes will tend to produce both. It is generally agreed that the most common cause for the former is disease of the oro-and epi-pharynx, and that the extension to the ear is wont to take place through the Eustachian tube. To this view we have not the least wish to take any exception. Indeed experience only impresses upon us the close relation which exists between the two localities, but to the equally popular teaching of the importance to be attached to affections of the nose in their effect on the ear, we have still to be convinced. At the same time we are willing to admit that marked obstructions in the nares can be accountable for a certain number of ear cases. Their number in our judgment is however small in comparison with the number due to other causes. Moreover it must be constantly borne in mind that we continually meet patients with complete nasal obstruction due to polyps or other neoplasms without any aural symptoms whatever. Indeed we would go further and say that we believe that in many instances where there is a well defined throat lesion, the ear disease is not dependent upon this but that there is a common cause producing both.

In line with what has just been said regarding the relation of otitis media chronica hypertrophica to sclerosis and bearing on the question of a common cause for affections of the throat and ear, we may be permitted to refer to the statistics of 21 cases of undoubted sclerosis seen recently in private practice. Many of them had undergone operations upon the nose or throat without benefit before coming to us, and what is of particular interest, in not one of them at the time of our examination was there what might be described as a gross nasal lesion, while in most there was no complaint addressed to the nose at all. Yet in 15, or over 66%, there was a clear history of repeated colds extending over several years. This complaint of repeated colds is the most significant feature of the history of many of these cases, and one upon which the greatest emphasis is to be placed. The cause in our judgment in the majority of instances is not to be found alone or chiefly in the nose, as is shown by the failure to relieve by nasal treatment in the cases just quoted and in many others with which you all are acquainted. This cause without question varies in the particular case. Rheumatism and gout have always been regarded as among the more common contributing causes. Our experience with gout in this country is of necessity limited, and we do not recall finding many cases where well established rheumatic history was obtainable. Rather do we think that emphasis should be put upon that condition which is often in the lay mind confused with rheumatism, and which very possibly is at the bottom of many cases, i. e., lithaemia or collaemia, as described by Haig, that condition of the system where a state of auto-intoxication exists due to the retention of certain products of excretion in the blood. We know that this accounts in no small degree for many cases of throat difficulty, and there is no question in our own mind that a similar cause operates not infrequently to set up or aggravate trouble in the ear. Another widely acting agent in exciting both pharyngeal and aural inflammation and one that we have yet to grasp the full significance of, are

bacteria. Most writers who have looked into the subject are beginning to believe that there is no difference etiologically between an acute catarrhal otitis and an acute suppurative otitis except in the virulence of the bacterial invasion. In addition to rheumatism, many other constitutional diseases have been suggested as exciting causes. Among these may be mentioned tuberculosis, syphilis, truma, arterio-sclerosis, and trophoneurotic changes which occur in tabes and allied affections. All can and do undoubtedly exist in connection with oto-sclerosis, but the direct causal relation is yet to be shown except as any profound constitutional disturbance must affect every organ of the body and render it more liable to disease. The **female sex** is especially prone to the disease, which would seem to suggest the probability that a highly organized nervous system such as is wont to be found in women, is an important predisposing factor.

Age would appear to have some bearing upon the onset of the disease. At least it makes its appearance in the majority of cases in early manhood and womanhood. In 733 cases reported by Lucae, it developed in 74% between the years of 21 and 50. In 87% of these, the affection was double sided pointing to the general character of the malady.

Pregnancy has been advanced as a possible cause. While it does undoubtedly occur that marked flagging of the hearing occasionally is noted at that time, it can only be regarded as an instance of the now well recognized intimate relation between the sexual and sensory systems. More striking than all other causes save the one of throat disease, is **heredity.** There can be no question that heredity plays an important role in oto-sclerosis. In 641 cases where records on this point were kept by Lucae, 235, or 37%, gave such a history, while Bezold puts it as high as 52% in his cases. When it is considered how difficult it is to obtain accurate information regarding this, due to the early death or separation of the parents or grandparents, there can be little question that the figures of Lucae are too low rather than too high. Highly

significant as bearing on the question of the frequency of a preceding chronic catarrhal otitis in the majority of cases, is the fact that of the 235 cases where heredity was shown, 77% had demonstrable pathologic changes in the tympanic cavity. This would seem to prove conclusively that inherited oto-sclerosis does not differ at all in this particular from the non-inherited variety. Quite in line with this observation and serving at least as a most ingenious explanation for this widely recognized peculiarity, is the theory of Von Troeltsch that the family likeness is to be found, as far as the ear is concerned, in a uniform narrowing of all its measurements, predisposing as soon as any inflammatory process has appeared, to an early throwing out of adhesive bands and the binding down of the ossicles in consequence. Siebenmann has also advanced the view that there exists an abnormal post-embryonic developmental process. Others have tried to show that the disease is especially wont to develop in those who are anaemic or disposed to worry. Certain it is that some general underlying predisposing cause is needed to explain so widespread and characteristic a feature of the disease.

A careful and painstaking review of most of the recent articles on the subject leads us to feel that not enough attention has been paid to this phase of the question, and in order that more definite and accurate data may be secured, we would urge that in all our future cases, we endeavor to secure the fullest information possible on every point which may, however remotely, assist in arriving at an authoritive answer to the all important question in the consideration of any disease—namely, what is the cause.

PATHOLOGY AND PROGNOSIS OF CHRONIC PROGRESSIVE HARDNESS OF HEARING: OTOSCLEROSIS.

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This title assigned to me is somewhat misleading; I should prefer to substitute "Pathology and Prognosis of **Chronic Interstitial Otitis.**" I am glad to have the opportunity to express my views on this subject since I think confusion has arisen by the loose way in which the terms otosclerosis and chronic progressive hardness of hearing have been used by various authors. I use otosclerosis to denote an interstitial inflammatory sclerotic condition of the ear especially characterized by vascular changes and usually located in the tympanic cavity or in its walls. The term otosclerosis is in no way expressive of the vascular ostitic lesions to which it is often applied. On the other hand, I use the term chronic progressive hardness of hearing to denote a class of ear affections due to changes in the middle ear or its walls, these changes being independent of ulcerative processes but characterized by chronicity and a tendency to increasing deafness. In exceptional cases the hearing appears to remain stationary for long periods. Most of the cases, all except the most advanced, may show arrest of the process and a degree of improvement under proper therapeutic and surgical management. Some of the synonyms used for chronic interstitial otitis are: 1. Dry chronic middle ear catarrh (Schencke). 2. Otosclerosis. 3. Chronic progressive deafness. 4. Otitis media insidiosa. 5. Rarefying ostitis of the labyrinth capsule. None of these terms are good. "Dry middle ear catarrh" does not express the pathological condition. "Otosclerosis" is an expressive term but it has been ruined by its eroniously restricted ap-

plication. "Chronic progressive deafness" has also been misapplied. "Otitis media insidiosa" is a rare form of chronic interstitial otitis and the term is not sufficiently comprehensive. "Rarefying ostitis of the labyrinth capsule" is inadequate since it defines only a local terminal condition of the general pathological process. My only excuse for mentioning these different terms is an attempt to explain away a misunderstanding in order to go back to the fundamental etymo-pathological meaning of the words. For the general pathological condition we are considering I would prefer to use the term **chronic interstitial otitis** with a special adjective referring to the parts affected in any one particular case, as otitis interstitialis chronica membranae, otitis interstitialis chronica ossiculae, otitis interstitialis chronica promontorii et fenestri ovalis, otitis interstitialis chronica labyrinthi.

Coming back now to our subject, the results of clinical observation and treatment show that chronic interstitial otitis is due to middle ear, tubal and nasopharyngeal disturbances in many cases and to constitutional causes in others, or to all combined. The nasopharyngeal disturbances seem to work in a reflex way through the complicated nerve connections of the tympanum. Ever since I took up our specialty I have paid a great deal of attention to this subject and the overwhelming evidence of my clinical observation and experience together with laboratory work have forced me to accept the following views.

1. **Pathology.** The pathology of the condition under discussion is dependent upon vascular disturbances affecting the blood supply of the tympanic cavity and walls, with resultant trophic changes. These pathological processes have been described by many authors. The alteration in the blood supply causes either a hyperemia or anemia. Either of these conditions may be primary, but the anemia alone can be secondary. The primary anemia is of vasomotor origin and is usually found in young females. It has been described under the name of "otitis media insidiosa," a rare condition. The disturbance of the blood supply may

be general or confined to one or more of three regions: (1) The drum membrane, (2) The major ossicles, (3) The stapes and labyrinthine wall. The changes are in most cases unequally distributed throughout the tympanum and in some cases may be sharply defined and limited to very small areas. Different stages are usually present at the same time. For instance, extreme atrophic thinning, degeneration, calcification and fibrous thickening may be present in the same membrane. These circumscribed areas of different processes give a mottled appearence to the tympanic membrane.

There is nothing peculiar to the trophic changes caused by the altered blood supply of the middle ear. These changes are identical with the results of similar causes in other parts of the body, namely congestion, vascular proliferation, infiltration, interstitial inflammation, hyperplasia, contraction, compression of blood vessels, anemia, degeneration, calcification, vascular ostitis or osteoporosis, and hyperostosis. The peculiar feature exhibited by the middle ear is the very limited and sharply circumscribed area of the changes. The reason why similarly circumscribed changes are not found in other regions is that nowhere else do similar anatomical relations occur. The almost terminal arterial supply of the tympanum and its walls, where the mucoperiosteum of the tympanum admits of a blood supply running in one plane only, tends to render the blood supply subject to extreme variation over small areas. This tendency is enhanced by the peculiarly complicated arrangement of the tympanic plexus of sensory, motor and sympathetic nerves. Similar anatomical arrangements are not found anywhere else in the body. The tympanum has another peculiarity: Wholly independent of central influences it can control its own blood supply through its ganglionic connections. This control is brought about by the direct connection of the carotid and the minor vascular plexuses of the tympanic system through the intervention of the sensory nerves of the drum cavity. The nerve ganglia connected with the ear make it more subject to vasomotor changes due

to local causes, than any other regions can possibly be. Among the most important causes of hyperemia are infectious processes of all grades whose resultant cicatricial contractions produce local anemia.

Because the mucous membrane is the most liable to vascular change, the pathological changes under consideration affect this first; next they affect the sub-mucous or periosteal layer, and last the bone. The pathology is exceedingly simple, but owing to the variety of structures involved and the location of the processes the resultant subjective and objective effects are quite varied. Certain areas of the tympanum, the oval window, promotory and drum membrane are most often affected because these areas are more subject to reflex vasomotor and other vascular changes. These parts also are more apt to attract attention because of marked symptoms.

The congestive stage of the process is accompanied by vascular increase and later cellular infiltration; increase of fibrous tissue results, the contraction of this new connective tissue shuts off the blood supply and nutrition suffers with signs of degeneration and loss of pliability of the connective tissue. After the congestive stage is passed, the mucosa, mucoperiosteum and drum membrane have thickened and become grayish white. Later there may be a deposition of lime salts in the fibrous and periosteal layers. Osteoporosis follows the vascular otitis or congestive stage in the bone. The diminished blood supply of the periosteum and bone caused by the fibrous contraction and shutting of the vessels results finally in absorption of bone or osteoporosis and in the end hyperostosis occurs following the bone absorption and in conjunction with it.

Cross examination and histological findings of the tympanum show one or more of the above mentioned pathological conditions which take the following forms: I. The congestion of the drum membrane due to an engorgement or an increae of the vessels of the mucosa, later similar changes of the membrana propria. II. Anemia of the

drum membrane due to contraction or compression of the vessels. III. Opacity of the drum membrane due to a loss of transparency of the mucous or fibrous layers from cellular infiltration, fibrous thickening or degenerative processes and calcification of the connective tissue. IV. Thickening of the drum membrane accompanied by opacity and due to the cellular infiltration and an increase of the connective tissue element. V. Thinning of the drum membrane due to atrophy of the mucous layer and of the membrana propria. VI. Functional impairment of ossicular sound transmission from congestion and oedema of the ossicular articulations especially of the orbicular articulation of the stapes. VII. Contraction of fibrous adhesions of ossicles, drum membrane or tympanic walls. These adhesions are due to hypertrophy or contraction of the normal mucous membrane reduplications or to cicatricial adhesions. VIII. Rigidity of the articulation of the major ossicles and stapes due to atrophy and degeneration of fibrous tissue. IX. Congestion and cellular infiltration of the promotory similar to the corresponding changes in the drum membrane. X. Functional rigidity or impairment of motion of the stapes without ankylosis due to congestion and cellular infiltration. XI. Rigidity of the stapedio-vestibular articulation and fibrous ankylosis due to contraction of new fibrous tissue. XII. Bony ankylosis of the foot plate of the stapes due to hyperostosis of the stapes and oval window. XIII. Vascular ostitis and osteoporosis of the ossicles and tympanic walls. XIV. Hyperostosis of the ossicles and tympanic walls. XV. Hyperostosis of the labyrinthine walls, encroaching upon the labyrinthine spaces and interfering with the functions of the mebranous labyrinth.

The bone changes begin with a thickening of the mucoperiosteum due to increased vascular formation and cellular infiltration. The nutrient vessels of the bone undergo similar changes. Later the new connective tissue formed from the infiltration cells contracts, compresses the vessels and lessens the blood supply and interferes with the nutrition of the bone causing the formation of lacunae. Slightly later

in the process but concomitant with the vascular ostitis, the periosteum commences to form new bone in the form of irregular hyperostoses. The bone changes are most apt to commence in the neighborhood of the oval window and are usually found in the outer labyrinthine wall.

The pathology is founded on the etiological basis of primary and secondary disturbed circulation, due to local or general causes. Because of the notoriety certain authors have brought upon these conditions and on account of the nomenclature erroneously applied to them, the pathology of the bone changes taking place about the stapes and in the labyrinthine capsule and other parts of the tympanic walls and temporal bone deserves special mention. Many authors have been surprisingly unanimous in their observation concerning the pathology of the condition rightly called rarefying ostitis. When, however, it comes to the steps which lead to this final condition, there is a great variance of opinion which increases when the primary patholo-etiological factor is under consideration.

Many authors maintain with plausible arguments that this condition is a true bone syphilis; others equally plausibly disprove the presence in many cases of syphilitic infection. What then is the explanation? If we compare the progressive pathological steps and the histological findings with the course and result of syphilitic bone inflammation, we find an absolute identity of changes and histological pictures. First there is an engorgement of the blood vessels followed by interstitial infiltration of round cells causing an increase of connective tissue elements. Then contraction of the connective tissue takes place shutting off the blood supply, next vascularization and vacuolization of the bone commences and finally new bone is formed.*

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*Schenke. Anatomischer Beitrag zur Frage der bei dem trockenen chronischen Mittelohrkatarrh (Sklerose?) vorkommenden Knochenerkrankung des Schläfenbeins (chronische vaskuläre Ostitis, Volkmann) etc. Arch. f. Ohrenheilk. Vol. 53, p. 68 and plates 1901.

Habermann. Zur Pathologie der sogenannten Otosklerose. Archiv f. Ohrenheilk. Vol. 60, p. 37 and plates, 1903.

Parrot. La Syphilis Héréditaire. Masson, Paris, 1886. Plate 20, fig. 1.

We know that the tympanum is subject to vasomotor changes which finally cause diminution of blood supply and atrophic changes. We know from frequent observation that the oval window and promotory are especially liable to chronic congestive states. Why should not the congestion produce the same result on the promontory as elsewhere and why should not this result take the same form and produce the same alterations as similar vascular changes do in other bones? In default of a more logical primary pathological cause for vascular ostitis of the labyrinth capsule, I believe it may perhaps be due to syphilis in some cases but in the great majority of cases I believe it is due to altered blood supply of the lining mucoperiosteum of the inner wall of the tympanum independent of syphilis. Chronic interstitial otitis, including cases previously described under otosclerosis and spongefying ostitis of the labyrinth capsule, may follow, as we have seen, suppuration and infection as well as vasomotor changes and so-called "chronic middle ear catarrh" and therefore chronic interstitial otitis is a comparatively common affection. The pathological changes in chronic interstitial otitis following suppuration are due to the diminished blood supply caused by interstitial infiltration brought on by the suppurative inflammation which ends in fibrous contraction. That rarefying ostitis should be hereditary is natural, since it depends on nervous instability and morphological irregularities, qualities which are hereditary to a degree.

II. The prognosis of chronic interstitial otitis is foreshadowed in the pathology. Without treatment the prognosis indicates a more or less gradual progressive deterioration of hearing. Under treatment the prognosis is favorable for improvement or prevention of further loss of hearing unless the pathological changes are already far advanced. This improvement is possible because the fundamental causes of the altered blood supply which is the primary cause of the interstitial otitis, are either local, nasopharyngeal or general conditions amenable to special

treatment. If the blood supply is rectified before tissue changes have taken place, no sign will be left of the disturbances. The prognosis for the revitalization of degenerated tissues is dependent upon the prognosis for the improvement in the blood supply and our power to regulate the local vaso-motor functions. If vaso-motor regulation is established and the blood supply is correct after tissue changes have taken place, the prognosis depends upon the ability of the patient to respond to the improved condition and to overcome the existing pathological changes. The improvement in the ear following the improvement of the blood supply may extend to a complete restoration of function and return of the normal appearnces of the drum membrane and ossicular chain. The prognosis is good if the congestive stage has not been passed, and good also after the progressive tissue changes have commenced up to the time the degenerative changes are very far advanced. The prognosis for the improvement and correction of adhesions by cutting and stretching is good. The prognosis for overcoming ankylosis is good if bony ankylosis and extreme degenerative states have not taken place. In bony ankylosis the prognosis is absolutely bad.

The previously published cases are illustrative of the prognosis in the more doubtful or advanced conditions.

1. Case No. 14,229. A man, aged sixty-seven. Deafness commenced eight years ago; hearing has been very bad for three years; this condition was possibly aggravated by business failure. Hearing variable. Drum membrane whitish and opaque. Position, contour and light reflex normal; malleus movable. Politzer's acoumeter heard in right ear at 4 inches, in left ear at 3 inches. Loud conversation heard in right ear at 6 inches, in left ear at 32 inches. Watch not heard in either ear. Bone conduction much shortened. Low limit for tone perception by bone, 128 single vibrations. Low limit for tone perception by air conduction above 256 single vibrations which were not heard by air. High notes well heard. Treatment by general

hygiene and regulation of blood supply of the middle ear. Six months later, Politzer's acoumeter heard in right ear at 7 feet; watch at 20 inches; in left ear, Politzer's acoumeter heard at 4½ feet. Improvement has continued now for a period of four years.

2. Case No. 13,083. A man, aged forty-seven, had noted deficiency in hearing for eighteen years. Drum heads good color, fair contour and position, light reflexes very small. Nares partially occluded by hypertrophies and irregularities. Fossae of Rosenmüller partially closed by adhesions. Tubal mouths slightly obstructed by thickened mucosa. Watch heard in right ear at 15 inches; in left ear at 4 inches. Astringents and irritants applied to nasopharynx. Three years later watch heard at 48 inches in left ear and 84 inches in right ear. Improvement maintained.

3. Case No. 13,036. A man 24 years old. Family history of deafness. The attack commenced one year ago. Drum membrane normal. Buzzing tinnitus, and sounds like the ocean and various other noises. Politzer's acoumeter heard at 12 inches. Treatment: Astringent applications to the nasopharynx. Fifty-two days later, Politzer's acoumeter heard at 8 feet. Tinnitus very faint. The improvement has continued.

4. Case No. 13,071. A woman 74 years old. Hearing has been diminished some years. Drum membrane has small reflex and good color. It is contracted but not retracted. Congestion of promontory. Politzer's acoumeter heard in right ear at 10 feet. In left ear at 27 inches. Watch not heard. Intranasal and naso-pharyngeal treatment for thickened mucosa with stimulating astringents. Twelve days later, Politzer's acoumeter heard in right ear at 15 feet; in left ear at 42 feet. Two years later same watch heard at 4 inches in both ears. Improvement well held; very slight decrease during four years due to senile change.

Conclusion. Pathology. Exclusive of infectious conditions there is but one fundamental pathological condition in the middle ear, which frequently interferes with normal

hearing, namely chronic interstitial otitis. All the various forms of atrophic processes, "chronic dry catarrhs" and "ostitis spongiosa of the labyrinth" come under this head. The nutritive changes may be inaugurated by local, reflex, or general causes. The local causes include inflammation, infection, and suppuration. The general causes work through nervous and blood supply changes.

The **prognosis** indicates a more or less gradual deterioration of hearing. Under rational treatment the prognosis is good for arrest of the progressive deterioration of hearing and improvement of audition in inverse ratio to the advances already made by the pathological changes.

SYMPTOMS AND DIAGNOSIS OF OTOSCLEROSIS.

By GEORGE E. SHAMBAUGH, M. D., Chicago.

An insidious onset of deafness, beginning usually in early middle life, involving often but one ear primarily, yet as a rule including later both ears, associated usually with tinnitus aurium, and leading frequently after the lapse of years to profound deafness, this forms the usual clinical picture of the condition known as otosclerosis.

The gradual onset forms one of the most characteristic symptoms and on account of this insidious character it frequently happens that when the process is limited to one ear, and especially where tinnitus aurium is absent, the deafness becomes far advanced before the patient is aware that he has any defect in hearing. On the other hand in exceptional cases the progress of the defect in hearing is quite rapid, so that in the course of a few months' time the defect already becomes very marked.

There is no other form of ear trouble which so frequently involves both ears as does otosclerosis. This conforms with our knowledge of the etiology that some underlying hereditary condition is the all important factor. Still it is not uncommon for the process to be confined to one ear for a number of years, producing a profound defect in the hearing in that ear before anything can be detected on the opposite side.

Tinnitus aurium in some form is usually present Its onset may antedate any detectable disturbance in hearing. On the other hand it may appear after the defect in hearing is well advanced. It may be intermittent, although as a rule it is constant. In pitch it may be high or low, and it is not uncommon for patients to complain of several quite distinct types of tinnitus at the same time. I have several

times seen patients who described three distinct types of subjective noises with sometimes the one and at other times another temporarily increasing, so as to practically drown out the other two. A temporary increase in the subjective noises is usually associated with an increase in the deafness.

The deafness does not by any means invariably become severe. Often the progress of the condition is either so slow that no increase in the deafness can be detected for a number of years, or else there are periods of longer or shorter duration when the condition remains practically stationary.

There are other symptoms which are complained of with more or less frequency by patients suffering from otosclerosis. These are a sensation of fullness in the ear, slight pain deep in the ear, alteration in the severity of the deafness and the subjective noises depending on the condition of the weather or the presence of physical or mental fatigue. These patients are also frequently subject to slight attacks of vertigo attributed to an involvement of that part of the labyrinthine capsule covering the semicircular canals and the vestibule. Paracousis Willisi is more marked in otosclerosis than in any other form of ear trouble. Objectively the occurrence of Schwartze's symptom is the most significant. This consists in the presence of a reddish glow transmitted to an unusually transparent membrane tympani from a congestion of the mucus membrane covering the promontory. This reddish glow may be constantly present or it may be brought out only after catheterizing the Eustachian tube.

In the diagnosis of otosclerosis this condition must be distinguished on the one hand from cases of nerve deafness, and on the other from deafness due to middle ear disease.

In the diagnosis from nerve deafness it will be convenient to consider separately three distinct types of otosclerosis. First, those cases where the defect in hearing is due entirely to the fixation of the foot-plate of the stapes; second, those cases where in addition to the defect in hearing caused by the fixation of the foot-plate of the stapes there is also a

more or less extensive defect in hearing caused by an involvement of the structures in the cochlea; and third, those cases of otosclerosis where the spongifying of the capsule of the labyrinth has produced no interference with the action of the foot-plate of the stapes and where the defect in hearing is therefore due solely to disturbance in the function of the structures in the cochlea.

In the first group of cases where the defect in hearing is due solely to the fixation of the foot-plate of the stapes the diagnosis from nerve deafness presents no difficulties for even in the incipient stages of this process, and where the defect in hearing for the voice is but slight the interference with the action of the stapes already produces the prolongation of the bone conduction, the shortened positive, or even negative Rinne, and the elevation of the threshold for the perception of the lower tones which are characteristic of an obstruction in the conducting mechanism. In nerve deafness just the opposite reactions are found. Here the duration of bone conduction is more or less shortened, provided both ears are involved. The Rinne is always positive, when the tuning fork can be heard at all, except of course in those cases of nerve deafness which are limited to one ear where the Rinne will be negative, provided the defect in hearing is at all marked. In partial nerve deafness, too, the defect in hearing is limited, as a rule, to the upper part of the scale, although of course it is not impossible in nerve deafness to have a disturbance limited to the upper coils of the cochlea with a defect for the lower tones while the higher tones will still be heard normally.

In the second group of otosclerotic cases, where in addition to the defect in hearing produced by fixation of the foot-plate of the stapes there is also a more or less extensive defect due to involvement of the structures in the cochlea, the diagnosis is often by no means so clear. This is particularly true in those advanced cases where the labyrinthine deafness is extensive, a condition to which the term disacousis has been applied.

The underlying pathological process in otosclerosis, the spongifying of the bony capsule of the labyrinth, while beginning in most of the cases in the immediate neighborhood of the fenestra vestibuli and in this way producing usually an early fixation of the foot-plate of the stapes, is not always restricted to this part of the labyrinth capsule. The same change may take place in other parts of the capsule as well, producing as we have already pointed out the disturbance in equilibrium, when the vestibular part of the capsule is involved. In the same way, apparently, disturbances in the function of the organ of Corti are produced when the adjacent capsule of the cochlea becomes involved in this spongifying process. These disturbances in the cochlea appear to be circumscribed, and limited in a measure at least to the areas in the cochlea in more or less close relation to the part of the capsule involved. It is probably in this way, we have produced in most of the typical cases of otosclerosis, even in the incipient stages, a defect for the higher notes of the Galton whistle, because that part of the organ of Corti stimulated by the higher notes of the Galton whistle lies under the promontory in close relation to the fenestra vestibuli, in other words, in close relation to the part of the labyrinth capsule involved in the spongifying process. Bezold has found cases of otosclerosis with circumscribed defects in the middle of the scale for part of the Galton whistle, and I have this past year studied a case of probable otosclerosis in which was found a circumscribed tone island as well as a circumscribed defect in the midst of the tone scale.

With the knowledge of the fact that in otosclerosis the disease of the capsule of the labyrinth is not always limited to the region of the fenestra vestibuli, but may spread more or less extensively throughout the capsule of the cochlea, producing a loss of function of the part involved, we can readily understand these cases of disacousis where in addition to the defect in hearing produced by the fixation of the foot-plate of the stapes there exists a more or less extensive

involvement of the capsule of the cochlea with symptoms of nerve deafness. These cases fall naturally into two groups: first those cases where in addition to the defect in hearing produced by the fixation of the stapes there is a defect due to a more or less extensive involvement of the basal coil of the cochlea. In these cases we will find in addition to the elevation of the lower tone limit a more or less extensive defect for the higher notes of the Galton whistle, yet the Rinne will be found to be negative and there will be found a prolongation of the bone conduction.

The left ear in the following case is an example of this group. Mr. B., 54 years old. His father's mother was deaf for many years. His father had a sister 70 years of age, who was quite deaf. Of her six children, two are somewhat hard of hearing. The patient's father began to be troubled with impaired hearing at the age of 25. He lived to be 73 years old, and suffered for many years from severe deafness. The patient has one sister 44 years of age, who has been hard of hearing for 15 years. He has one brother 50 years old, whom I have examined, who is suffering from an advanced stage of otosclerosis, with more or less extensive nerve deafness, as evidenced by a marked defect in the upper part of the scale. The patient himself began to notice loss of hearing when he was 14 years old; first in the right ear, but later in both. He has always had some tinnitus aurium, much worse in previous years than lately, and Paracusis Willisi is very strongly developed. An examination found the drum membrane practically normal, with slight thickening, and the Eustachian tubes normal. Whisper could not be heard in either ear. Spoken voice "28" heard somewhat clearer in left ear. In the Weber test the A fork is lateralized indistinctly to the left ear. The Schwabach test shows marked prolongation of bone conduction. Rinne for the a^1 fork is strongly negative for both ears. The lower tone limit for right ear is 30 d. v. There appears to be in this ear an indefinitely limited defect in the scale between h and c^4, and a well marked tone island from c^4 up to mark

"14" on the Edelmann Galton whistle. From "14" to upper limit there is a total defect. In the left ear the lower tone limit is 40 d. v. All tones above 40 are heard up to mark "11" on the Edelmann Galton whistle. Above "11" there exists a total defect. In this case the defect in the lower part of the scale, that caused by the ankylosis of the stapes is greater in the left than in the right ear, but the defect throughout the scale and at the upper limit, that caused by the involvement of the cochlea, is more extensive in the right ear. The result is that the patient relies on the left ear exclusively for hearing, and it is to this ear that the bone conduction is lateralized in the Weber test.

The second group of cases of dysacousis includes those where in addition to the defect in hearing produced by the fixation of the foot-plate of the stapes and the loss of hearing for the higher tones produced by the spongifying of the promontory there exists extensive nerve deafness throughout the middle of the scale, evidently because of the involvement of the capsule of the cochlea at a distance from the oval window. The right ear in the case just cited is an illustration of this group. The functional tests in these cases, provided the hearing in the opposite ear is gone or both ears are similarly involved, may give all the typical reactions due to nerve deafness that is a pronounced defect in the upper part of the scale for the Galton whistle, a shortened bone conduction, and a positive Rinne for the a^1 fork and in addition there will be the marked elevation of the lower tone limit due to the fixation of the stapes. Whether the Rinne will be positive or negative in such cases depends upon whether the deafness for the particular fork used in making the test is part of the defect in hearing resulting from the fixation of the stapes, or whether the deafness for this fork is the result of disturbance in the cochlea due to the spongifying of its bony capsule. In the first case the Rinne will be negative while in the latter it will be positive. This also applies to the results obtained in making the Schwabach test. The duration of bone conduction may be prolonged or

shortened, depending on whether the defect for the fork used is caused by the fixation of the stapes or by changes in the structures in the cochlea. When these facts are kept in mind we can readily understand the explanation of such results as a prolongation of bone conduction for the A fork and at the same time a shortening of bone conduction and a positive Rinne for the a^1 fork in the same case, a result not infrequently met with.

We come now to the third general group of otosclerotic cases, those cases where the foot-plate of the stapes has remained free, and where the spongifying of the capsule of the cochlea has produced more or less extensive nerve deafness.

Siebenmann was the first to report the postmortem findings in such a case where the functional tests indicated nerve deafness, and where foci of spongifying in the capsule of the cochlea established the diagnosis of otosclerosis.

The diagnosis of these cases from the other causes of nerve deafness cannot, with our present knowledge, usually be made. In some of these cases, however, the diagnosis of otosclerosis can still be made with a reasonable degree of certainty. One such case I presented before the Chicago Laryngological and Otological Society in 1903*. This case was briefly as follows: A young man, 27 years old, a university student, general health good, no previous general illness, and no history of syphilis, began three years previous to detect insidious development of tinnitus aurium and defect in hearing, first in one ear, but after a few months involving both ears. There was complete absence of any evidence of middle ear catarrh. The membrana tympani in both ears was quite normal, but showed in a most characteristic manner the reddish glow transmitted from the wall of the promontory, which Schwartze first pointed out as characteristic of otosclerosis. Here we have a history with

*Otosclerosis or Spongifying of the Capsule of the Labyrinth. Annals of Otology, Rhinology and Laryngology, March, 1903.

symptoms and physical findings typical of otosclerosis, yet the functional tests discovered the findings typical of an involvement of the inner ear. They were as follows: Whispered voice heard in right ear only when close to the meatus, in the left ear at six inches from meatus. The Weber test lateralized in the left or better hearing ear. The duration for bone conduction was markedly shortened and the Rinne was positive. The C fork (64 d. v.) was heard by air conduction normally in both ears, while the hearing for the c^4 fork was markedly shortened. From the history of this case with the physical findings and the results of the functional tests I believe the diagnosis of otosclerosis was justified, the spongifying process having involved extensively the basal coil and even the wall of the promontory, as shown by the presence of Schwartze's symptom, producing the typical picture of nerve deafness, but leaving, up to that time, the foot-plate of the stapes free, and therefore giving none of the results of obstruction in the conducting mechanism so characteristic of the usual case of otosclerosis.

I have studied another case this past year where the functional examination shows an extensive involvement of the cochlea, and yet where the absence of any constitutional disease that is known to produce labyrinthine deafness, and the fact that the process was an insidious one, coming on before the age of 20, when taken with the fact that a brother had developed the same type of deafness, coming on in exactly the same way, lead me to believe that we had probably to deal with otosclerosis in which the basal coil of the cochlea was involved without producing any interference with the foot-plate of the stapes (1).

The diagnosis of otosclerosis with fixation of the stapes from deafness due to middle ear disease can, as a rule, be readily made. Whenever there is found a normal drum membrane and Eustachian tube in a case of insidious

(1) A Case of Labyrinthine Deafness with "Tone Islands." The Laryngoscope, Vol. XVIII, P. 343, May, '08.

development of deafness where the functional tests show an interference with the conducting mechanism, such as a prolongation of bone conduction, a negative Rinne, and a decided elevation of the lower tone limit, the diagnosis of otosclerosis is justified.

In the incipient cases of otosclerosis, where the defect in hearing is still only slightly developed, the question will sometimes arise whether this defect might not be due to an adhesive middle ear catarrh in which the alteration of the drum membrane is so slight as to be scarcely discernible, Yet in these incipient cases the diagnosis of otosclerosis can often still be made with a reasonable degree of certainty by finding the evidences of obstruction in the conducting mechanism, the prolongation of bone conduction and the elevation of the lower tone limit, developed out of proportion to the degree of deafness.

It is often claimed that a diagnosis of otosclerosis in these incipient cases can be made by noting the absence of improvement in hearing after inflation, whereas in beginning deafness due to catarrh of the middle ear, considerable improvement after inflation is usually noted. This test cannot always be relied upon, as one occasionally finds considerable improvement in hearing after inflation in these cases of beginning otosclerosis, where the foot-plate of the stapes is still apparently not firmly fixed by ankylosis. I have under observation now a young woman who consulted me a few years ago because of beginning deafness and tinnitus aurium. After making an examination a diagnosis of incipient otosclerosis was made, yet in this case, after half a dozen inflations with massage of the ossicles, the hearing improved for the whispered voice from 2 feet to 9 feet in the one ear affected at that time. The subsequent history has shown conclusively that the diagnosis of otosclerosis was correct, although the improvement in hearing continued for the greater part of a year before the progress in the condition overcame the temporary loosening up of the stape thus brought about.

Still more difficult of diagnosis than these incipient cases are those cases where an otosclerosis develops on top of some previous middle ear disease. Anything like a positive diagnosis in such cases is usually out of the question. Still otosclerosis may be suspected in spite of the presence of alterations in the membrane tympani where the development of the deafness is an insidious one, coming on in early adult life, and where the functional tests show, in proportion to the degree of deafness, an exaggerated prolongation of the bone conduction and negative Rinne, together with a marked elevation of the threshold of hearing for the lower tones and a well developed defect for the higher notes of the Galton whistle. The diagnosis of otosclerosis will be all the more certain in such cases when the history shows other cases of deafness in the same family coming on insidiously in middle life and resulting finally in profound loss of hearing.

With the knowledge that the process known as otosclerosis or spongifying of the capsule of the labyrinth is by no means restricted to producing bony anchylosis of the foot-plate of the stapes, but that there occurs at times a more or less extensive involvement of the capsule of the cochlea, producing symptoms of nerve deafness, as well as of deafness due to fixation of the stapes, the problem of diagnosis becomes at times one of the most difficult in the whole field of otology.

On the other hand, as I have attempted to bring out in this paper, with the knowledge we now have of the pathology of this condition, the manner of onset, and the associated clinical symptoms, the diagnosis of otosclerosis not only from nerve deafness, but from other conditions producing obstruction in the conducting mechanism, can usually be made with all the positiveness which any problem in diagnosis permits.

Discussion.

Dr. E. B. Dench, New York: My own experience is that most of these cases show evidence of a preceding middle ear lesion. In the majority of cases it starts in the tympanic cavity, although in some it begins in the bony cavity. In reference to nasal conditions I am inclined to attach more importance to them than does Dr. Harris. Not that if you have an otosclerosis you will improve the hearing, but that you may make the progress of the disease less rapid by diminshing the recurrent attacks of congestion in the tympanic cavity to which these cases are so subject. It is of importance in preventing slight recurrent attacks of congestion which hasten the progress of the disease. The history of repeated colds suggests a lowered resistance on the part of the patient and explains why the disease progresses more rapidly in patients of this kind. They have frequent colds simply because their genral nutritive processes are below par. The same applies to pregnancy; naturally it is a normal condition and with an individual with good reparative powers there should be no effect on the organs of special sense, but in women below par the condition is affected unfavorably by repeated pregnancies. At the menopause the progress is apt to be rapid unless the patient is kept in good condition. Rheumatism and gout I have never felt convinced had any influence on the condition. As to heredity, I am not as strong a believer as the German authorities in this respect, because given a case of sclerosis, they say, yes there is history of ear trouble in the family, but if you go into the matter further you find it but simply a suppurative process and could have had no influence on the sclerosis.

Dr. Arthur B. Duel, New York:—For a number of years I have felt sure in my mind that the question of nomenclature in chronic deafness was not at all satisfactory; the so-called otosclerosis being made to father a number of cases in which examination showed a definite anatomical change in the

labyrinthine capsule, while others showed a difference in the functional tests only. I feel sure that when the subject has been entirely worked out a certain class of cases will be considered as entirely hereditary. If you look carefully into the history of your cases you find that a large percentage give a history of deafness of a brother, sister, father, grandfather or perhaps a great grandfather, and all this has been taken down in an indefinite sort of way. In recent years a number of cases have been worked out in which there was a history of the disease being handed down from father to son while others of the family went free. The question arises why, if it is hereditary, it should happen to only one in the family. But this matter has been worked out quite recently.

I intended to call attention to this fact and say that I thought eventually it would be worked out satsifactorily when in coming down here I had my attention called to a little article in Harper's Weekly which has a bearing on this subject, entitled "The New Science of Progeny." An Abbott, of Brunn, who died about 25 years ago at a ripe old age, had dabbled in science and published a few papers upon the question of the crossing of pease and hawkweeds occurring in his gardens. Very little atention was paid to this until in '96 some men were impressed with his ideas and applied them to animals, working out definitely this scientific problem. How the question of why one child in a family should have inherited a chronic progressive deafness or any anatomical defect, characteristic family defect, is definitely explained. It would be impossible for every child to inherit the defect according to this new theory. I advise all of you to get the journal and read this short article. The experiments began in the cross breeding of varieties of pease that grew in the garden. Among other things he crossed tall pease with dwarf pease, sowed the seeds that resulted and found that all the progeny were tall, then he allowed the tall progeny to self fertilize and found that the next generation consisted of both tall and dwarf pease, in the exact

proportion of three tall to one dwarf. He found that in cross breeding the physical characteristic of the dominating parent reappeared through all generations in the general proportion of three to one: first generation; tall, fertilized by dwarf. Second generation: all tall. Third generation: Tall (A); tall (B); tall (C); dwarf (D). Always one in three would be dwarf. Fourth generation: A's descendants will be tall forever unless cross breeding occurs. D's descendants will be dwarf forever. B's and C's descendants will be mixed in the proportion of three tall to one dwarf. The fourth generation will reproduce itself exactly as the third and the cycle will be maintained forever.

They carried these experiments on with animals and found, for instance, that in a certain variety of mice, called waltzing mice, if they were crossed with normal mice, since the waltzing habit is not dominant in the mouse but abnormal, the progeny were normal mice. But when these were inbred, the waltzing mouse appeared in the next generation in the ratio of one to three. Of every four mice born one was a waltzing mouse which, unless cross bred, could never produce normal mice; one was a normal mouse whose progeny could never waltz unless the waltzing strain were reintroduced by cross breeding; and two were normal mice that reproduced one waltzer to every three that were normal. The same experiments were carried on with angora rabbits and Belgian hares. When Angora rabbits were mated with Belgian hares the offspring were all apparently Belgian hares, the dominant type, but these, when inbred reproduced fifty-three Belgian hares to seventeen rabbits. A ratio of three to one. The discovery was applied to the breeding of fowls. Breeders had found a difficulty in raising pure blue Andalusians. It was suggested that the blue fowl might be hybrid offspring of a black crossed with a black and white and this actually proved to be the case. On crossing a black fowl with a black and white all the progeny proved to be blue and not until these all blue descendants were inbred did the black and the black and white reappear in the proper proportion.

There has been traced through four generations the children of a family that possess a certain deformity of the fingers. The deformity was the dominant character, and it was shown that all who did not inherit it could not transmit it, even when two normal members intermarried. On the other hand, when a deformed member married a normal the descendants possessed the dominant characteristics.

Now the important argument which comes from this is that if you wish to get rid of this particular type of otosclerosis, a certain anatomical defect, you will have to follow the lines of certain of our German friends and prevent intermarriage of those who have that condition.

Dr. N. H. Pierce, Chicago:—As Dr. Shambaugh says, we are all talking about different things. It puts me in mind of the meetings that we had about the time that the diphtheria bacillus was discovered, when one man would be talking about diphtheria and another about croup. Some are talking about tubal disease, some about inflammatory disease of the tympanic cavity, and others about spongification of the capsule. Dr. Bryant seems to be the most honest in the way he throws the gauntlet. He embraces the terms progressive hardness of hearing, spongification of the capsule, and other terms which have been in the past used to describe these cases of progressive deafness without inflammatory change in the membrane, but we cannot quote Toynbe and von Trosch in this way; that is ancient history. Von Trosch, although a great master in his day, never examined a case of otosclerosis under the microscope. He knew nothing about otosclerosis in the modern acceptation of the term. The history of this begins in '85, when a case of ankylosis of the stapes in the fenestra ovalis without other demonstrable change in the tympanic cavity was discovered. The next step was that of Betzold who diagnosed during life stapes ankylosis and after death of the patient by means of the microscope proved that the stapes was ankylosed. He diagnosed the condition during life and left to posterity his

symptomatic tripod, increased bone conduction, loss of lower tone limit, and negative Rinne. Toynbe's cases cannot be used in this connection, although showing a vast amount of work, as his specimens, being something like 1,137, were unaccompanied by clinical data and that robs them largely of value in this respect. Diagnostic data was not known in the days of von Trosch or Trautmann in this regard. Lucien represents the older school. He hates to give up the things of his youth probably, and while we will all take off our hats to such an eminent man, as Siebermann has recently said the manner in which he ignores modern research in otosclerosis is to be condemned. The nomenclature of diseases of the ear today is divided into tubal, inflammatory, spongification of the labyrinthine capsule and disease of the nervous mechanism. Dr. Bryant cannot justify his position of quoting pathology drawn from his inner consciousness. We must depend upon demonstrable facts. I believe if I asked him the amount of his own observation upon which he based the paper he has read today he would be unable to support his work. It is a mistake to do that. I have no other reason for taking this view than that of carrying on the work that will be recognized not only today but in years to come in this Society.

As regards the etiology, the first question is that of sex; in by far the great majority of cases, this disease is one of the female and in a great many cases it comes on after child birth. The change that occurs in the bone is the same that occurs in the female skeleton at the time of childbirth. Heredity is a strong element. In my cases intelligent people who have a knowledge of their forebears heredity is shown in 90% or over. Syphilis, as Dr. Bryant has said, may be directly or indirectly a cause. There is a very strong similarity between the changes in spongification and in bone syphilis. Gummae will naturally soften bone and repose new bone. That is the natural course of a gumma in bone. The same changes occur in spongification of the labyrinthine capsule. The normal bone is spongified and then new bone

corresponding to callous structure of the long bone is deposited. It doesn't require very much argument to persuade one that this is the nature of spongification. Siebermann's theory is important; he believes otosclerosis to be due to changes that take place in the islands of cartilage. In the long bones these islands of cartilage exist and by their means the long bones alter their shape and size. In the labyrinthine capsule, however, the size and shape is established at birth, or approximately, and these islands remain unchanged, but where this hereditary impulse exists these islands undergo change just as in the long bones (this was demonstrated by drawings from specimens).

Otosclerosis is a disease characterized clinically by progressive hardness of hearing with a healthy Eustachian tube and tympanic membrane that shows no change by otoscopy. In this diagram, you see a specimen that was reconstructed from specimens in Siebermann's clinic (demonstrating drawings).

As Dr. Shambaugh has said, this disease may be engrafted on any other inflammatory process and these are the cases that present the greatest difficulty. There is no difficulty in the diagnosis of an uncomplicated case of otosclerosis. That point has been dwelt upon thoroughly, but there is great difficulty in diagnosis where changes have taken place in the tympanic membrane or tube. In certain cases an otosclerosis with tubal disease engrafted on it will give the functional, picture of an otosclerosis, the prolonged bone conduction, loss of low tone limit and negative Rinne, and yet catherization or Politzeration will give marked benefit, and it is my experience that we had better not place very much hope in these cases. Therefore even in persons with evidence of inflammatory or tubal disease if we have the characteristic reactions of spongification our prognosis had better be guarded until we have observed that patient for some time.

Another point regarding differentiation; these cases may come up in court and be of forensic interest. I believe in the large majority of nerve cases, where the nerve degenera-

tion is without spongification, we will have a history of infectious disease or of some chemical poison. The most frequent poisons are quinine and salicylic acid.

Dr. B. Alex. Randall, Philadelphia:—I accepted the invitation to speak upon this subject with reluctance and doubly so when our Chicago friends assure us that the diagnosis of real otosclerosis is easy. I have only advanced to the point indicated by Dr. Shambaugh when he says several of his cases were probably otosclerosis; I have not advanced to the belief that all otosclerosis is not sclerosis but spongiosis. If we restrict this discussion to the cases of spongification I must confess my practical ignorance, although I have read a good deal on the subject.

The matter I want to discuss is prognosis. I see very few cases that seem to me hopeless and for those who are discouraged, and I think there are some who have felt that there is a considerable group which is progressively unfavorable in spite of everything that can be done for them, I would say I still believe with the older men that such cases are rare. I have felt that the rigidity which we have to deal with is such as Dr. Bryant has said. If my pathology in this matter is theoretical, it is based on clinical observation, not microscopic, upon improvement in my cases. I feel that the adventitious bands that cause pseudo ankylosis of the stapes are as important as the changes about the foot-plate and about the labyrinthine capsule, and anything we can do to relieve that rigidity, as by massage, etc., is of value.

I do not lay very much stress upon the matter of heredity and tell my patients, perhaps unwisely, that the question of heredity need not necessarily distress them or deprive them of hope. I believe heredity is often a factor, not so much of tympanic configuration as of nasal configuration, which gives a narrow nose prone to catarrhal troubles; and while I do not for a moment suggest that we can cure, or of necessity improve, cases of this type by nasal treatment, I do believe that it is important to put the nose in a good condition.

I have regarded as distinctly important the point made by Lőwenberg some years ago that if you blow a little chloroform vapor into the ear there is produced a sense of coldness in the cases that are progressive; that instead of there being a heating, irritating sensation there is the distinct cooling sensation. It would seem to me that that must have some bearing on the pathology. There is frequently a flush of the promontory such as Blake ascribed to pelvic disorder; I have found it early present in many of these cases. Here is a membrane already flushed and yet feeling a sense of chill on the application of chloroform vapor. These patients, generally women, do commonly have pelvic troubles and these may so undermine their health that for this reason alone treatment is unavailing and deafness progressive.

The treatment of these conditions, then, seems not without hope, so far as I have been able to make a diagnosis in the matter, and the hope seems to me to lie in pretty good steady treatment at intervals; not too hard pushed at any time; based upon an assumed pathology, perhaps, but upon clinical observation of the results of treatment. I feel that in a good many of these cases where I have arrived at a probable diagnosis of otosclerosis there has been improvement under treatment. In dealing with them I feel that the catheter is absolutely essential; that Politzerization is of no value and frequently capable of doing mischief. That is perhaps a kindergarten matter; but I find that there are men who do not use the catheter but Politzerize. To turn to another kindergarten matter—in the use of the catheter I always employ the Politzer bag with a rounded tip which fits directly, "ball and socket," into the catheter so that without undue pressure in the nose there is sufficient opposition and no leakage. Not having to uncouple the tube is of importance in the convenient use of medicaments, liquid as well as vapor. I believe in Delstanche's claim for the oily materials in catheterization. In the treatment of these cases I have gotten a good deal of value from the use of weak iodine solutions. I have also followed Richey's plan of

using silver and iodine so as to get the nascent silver iodide. I have gotten excellent results with dionin also. We have a wonderful absorbent in dionin; in the eye it accomplishes marvelous results and I think I have seen some of the same effects in the ear. I have also had good results with thiosinamine but rarely per catheter. I have used it subcutaneously (fibrolysin) and seen progressive gain under its employment. I have of late gotten a good deal of value from its use by the stomach in the form of a new combination under the name of cirrholysin (Allytcarbomide-Bismuth biniodide) which gives the iodine action, together with the action of thiosinamine.

Whatever line of treatment we adopt, it is our duty to our patients to take a fairly hopeful view and treat them energetically.

Dr. N. H. Pierce, Chicago:—As to prognosis, it is not necessarily a progressive deafness. We have all known cases that arrived at a certain degree and remained there the balance of life. These people have the greatest consolation in the assurance that the trouble doesn't necessarily mean complete and early deafness, nor that the tinnitus will lead to brain disease.

As to treatment, in a disease similar to that of spongification, surgeons have seen benefit occur with the use of phosphorous, but it is difficult to see how phosphorous could do good in this disease about the stapes as it produces osteoid tissue to be deposited in the soft tissue.

Among the railroad workers in the Alps, it has been noticed that the engineers have been often seized by marked exaccerbation of deafness and of tinnitus which in a great number of cases has been progressive and permanent and this has been ascribed to the fact that they are subject to overheating and chilling of the body. This is very important and I have known of several cases where overheating and sudden chilling have been followed by increase in the deafness. It is necessary to warn our patients against this.

NONPURULENT LABYRINTHITIS AS A COMPLICATION IN ACUTE MIDDLE EAR SUPPURATION.

By BARTON H. POTTS, M. D., Philadelphia.

Purulent involvement of the labyrinth as a sequel to suppurative disease of the middle ear is being extensively considered at present, but not a great deal is being written about the nonpurulent inflammation that may result from an acute middle ear inflammation and it is this phase that will be considered in this paper.

The relation of the blood supply of the labyrinth to that of the surrounding regions plays a very important part in this consideration. The fact has been recognized for a long time that the vessels that supply the capsule communicate freely with the surrounding parts. If it were true, as contended by Hyrtl, that the blood vessels of the membranous labyrinth form a closed system without communication with the vessels of the surrounding parts, it would not be easy to understand how inflammation would extend from the tympanum through the ivory-like capsule to the labyrinth unless it should be through the oval or round window by contiguity. But if, on the other hand, the view of Politzer and Schambaugh be accepted that there is direct communication between the vessels of the mucosa of the tympanum and those of the membranous labyrinth, then we can readily see the direct course infection might pursue.

Schambaugh, in an extensive study upon the ear of the calf, has proven that there is communication between the blood vessels of the tympanum and those of the labyrinth, the chief point being the base of the cochlea. As corroborative evidence it might be cited that in suppurative labyrinthitis the cochlea is the primary seat of infection in the majority of cases and is injured to some degree in 90% of

all cases. We must remember also that the labyrinthine fluid is separated from the tympanum only by the foot plate of the stapes and the thin membrane of the round window. So that from an anatomical point of view it is possible to have direct infection of the labyrinth from the tympanum. It is true that this is more commonly the case in chronic middle ear suppuration, but that it may occur in the acute cases is also undoubtedly true.

Wittmaack says that it is presumable that in the labyrinth pathological processes generally occur in the form of small multiple morbid foci, in the form of small hemorrhages or inflammatory exudates or infiltrates, situated within the delicate membranous labyrinth. Then there may be serous exudates in the peri-or endolymphatic cavities of the entire labyrinth. The presence of bloody extravasations throughout the entire labyrinth, which was formerly regarded as the cause of Ménière's disease, is only possible from a traumatism with fracture of the labyrinth capsule.

When the labyrinth is filled with a serous exudate, or if the lymphatic circulation is suddenly interfered with, intense symptoms of irritation should be present. The occurrence of many small infiltrations will produce much less marked symptoms than when there is an extravasate occupying the entire labyrinth.

The diagnosis of labyrinthine involvement is sometimes very difficult. It may so closely simulate a cerebellar involvement that the diagnosis may for a time be impossible, both conditions being unusual in acute middle ear inflammation. To make the diagnosis of disease of the labyrinth we must have two symptoms, viz., a functional disturbance of the sound perceiving apparatus as well as of that for the maintenance of equilibrium. The temperature shows nothing characteristic. Headache is present as is the case in all inflammation of the temporal bone. Nausea and vomiting may be present, but are not of great value as symptoms because we must remember that they may be caused by strictly intratympanic disease and as symptoms they are of

value only when associated with other symptoms of the Ménière group. Tinnitus is apt to be present in the condition under consideration just as it may be in the early stages of purulent labyrinthitis and in both conditions it disappears when the nervous apparatus is destroyed. To be of diagnostic value the tinnitus must be of high tone, continuous and very loud.

As the cochlea is the part most often affected, so deafness is one of the most constant symptoms. In purulent labyrinthitis the general opinion seems to be that disturbances in equilibrium come next to deafness in frequency. In my own cases of acute non-suppurative labyrinthitis the vertigo was the most distressing symptom.

Wittmaack says (Z. f O. vol. L, No. 2, 1907) that we can regard vertigo as an aid to the diagnosis of disease of the semicircular apparatus only when it is present in the form of the typical rotatory vertigo—in other words, when we learn from the patient that he has the impression as if he or the surrounding objects turn. The presence or absence of this vertigo is important in the differential diagnosis between affections of the labyrinth and the auditory nerve.

Facial palsy would be of diagnostic value only when associated with labyrinthine deafness and disturbances of coordination and would be found rarely in the nonsuppurative condition. Nystagmus is an important symptom. When this condition is due to labyrinthine disease it is noticed when turning the eye to the well side and it becomes weaker and weaker and finally disappears as the destruction of the labyrinth progresses. The nystagmus due to cerebellar disease, on the other hand, increases with the progress of the disease and becomes much more pronounced than is ever the case in labyrinthine disease. Neuman says (A. f O. vol. lxvii) that if in the beginning of the disease the nystagmus is present only when the eyes are turned to the well side and then suddenly changes to a nystagmus when the eyes are turned to the affected side, a cerebellar disease may be diagnosed with certainty and a labyrinthine origin may be

excluded. Von Stein's test is of value in diagnosis, but is not at all conclusive as it is subject to several errors, though some of these errors may be eliminated by repeated trials.

The examination for labyrinthine involvment may be very exhaustive and prolonged. The tests for hearing. Static examination on a horizontal and on an inclined plane. Active and passive centrifuge tests and dynamic examination all have their value, but none are pathognomonic. In the type of cases presented in this paper it will be impossible generally to carry out the complete tests, first because of the severity of the symptoms, and secondly because the time required is over an hour and the patient is unable to undergo the exertion.

The treatment of acute nonpurulent labyrinthitis must always be vigorous and sometimes radical, though operative procedures are generally not to be directed to the labyrinth itself, but rather to the thorough drainage of the immediately surrounding parts. Without doubt the usual treatment for the middle ear inflammation will have been applied before the diagnosis of labyrinthitis is made or suspected. Calomel, saline, cold application, or hot douching and dry heat, free paracentesis and rest in bed, will have been found inadequate, for, in spite of these measures, the symptoms of deeper trouble develope. Free diaphoresis by pilocarpin should be tried; if this fails, then the iodide of potassium alone or in combination with sodium bromide, should be tried. If the condition does not respond promptly to these measures, then the mastoid should be freely opened and drainage maintained by this route.

A careful search for any direct communication with the labyrinth should be made and if none be found, the inner ear should not be disturbed. The points mentioned are well illustrated by the following report of three cases.

Case 1. S. J. J., lawyer, aet. 30 years. Family history negative. Previous history negative. The patient contracted a very severe cold in the head in November, 1906. He was treated by his physician but did not improve. About

two weeks after the onset of the cold he developed pain in the left ear. He employed various remedies for the relief of the pain for five days, when there was a discharge of a small quantity of a watery fluid and he then consulted his physician again. Treatment brought no relief, for thirteen days after the initial pain he began to complain of increasing pain in the ear, tenderness over the mastoid, occasional nausea and vomiting and some vertigo; he said that objects seemed to spin around.

I saw him in consultation at this time and found the following condition: marked congestion of the membrane and upper and posterior canal wall, with some sagging. The temperature was 99.2°; the pulse and eye grounds were normal. There was very marked tinnitus and some nystagmus on turning the eyes to the right. The patient could move around the room with difficulty by holding on to the furniture. He was put to bed and a free paracentesis done. Hot douching, dry heat, calomel and saline ordered. The discharge now became rather profuse; the nausea and vomiting subsided, but the vertigo became worse, so much so that he could not get out of bed at all; he said that the whole world seemed to be spinning. Potassium iodide was started and pushed rapidly, but without effect. There was some deep tenderness over the antrum. There was no change in temperature, pulse or eye grounds, but, as his distress was so great, it was decided to open the mastoid cells as an exploratory measure. This was done; there was some pus in the antrum under pressure. The region of the semicircular canals was carefully explored but found to be intact. Improvement began to be noticed about ten days following the operation.

The iodide was started again at this time and the vertigo gradually subsided. The mastoid wound was kept open about ten weeks and then allowed to close. The vertigo disappeared entirely, but the hearing was nil.

Case 2. E. M. M., school teacher; female; aet. 25 years. Family history negative. Previous history negative. On

January 14th, 1907, she developed a very severe attack of influenza; as this was subsiding she began to complain of a severe pain in the right ear. Four days after the onset of the pain there was a bloody discharge from the ear with some diminution in the pain. Ten days after the initial pain, the patient complained of nausea, vomiting and vertigo. The first two symptoms were not severe, but the vertigo speedily became intense, so much so that she was unable to sit up in bed; everything seemed to whirl around.

It was at this time that I saw her for the first time. There was marked congestion of the membrane and of the upper and posterior canal wall and slight sagging. There was slight tenderness over the mastoid. The temperature was 99.4, the pulse and eye grounds were normal. There was slight nystagmus on turning the eyes to the left. A very free paracentesis was done. Hot douching, dry heat, calomel and saline ordered. The nausea and vomiting improved rapidly and the pain over the mastoid subsided, but the vertigo increased. Hypodermics of pilocarpin were given for two weeks without effect. The patient had become absolutely deaf on the affected side and as her condition continued to grow worse it was decided to operate.

The mastoid cells were laid open freely and pus under some pressure was found in the antrum. The region of the semicircular canals was carefully explored, but found to be intact. The mastoid wound was kept open. Two weeks after the operation the vertigo had improved markedly; the iodide was started at the time and more rapid progress was noted. The nystagmus had disappeared. The mastoid wound was kept open for eight weeks and then allowd to close. The vertigo entirely disappeared, but the hearing was nil.

Case 3. J. L. M., physician; aet. 33 years. Family history negative. For the past eight years the patient has had an annual attack of influenza and tonsilitis, but no previous ear history. Following an attack of influenza about the first of June 1907, the patient began to suffer from pain in the

right ear; this was accompanied by tinnitus; there was a slight serous discharge. For this condition the patient consulted Dr. G. C. Stout, but, although under his skillful treatment, the condition became worse and a vertigo developed that was most marked when the head was turned from left to right; this was accompanied by nausea and vomiting. The patient had a personal preference for the German Hospital and he was admitted to that institution June 20th, 1907, and treatment continued by Dr. Stout and myself.

A first, hourly hot douching was employed and later dry treatment by means of a gauze wick. The discharge was never profuse. Calomel and saline were given. The patient was unable to raise his head from the pillow on account of the intense nausea and vertigo; the vertigo was of a distinct rotatory type. There was nystagmus on turning the eye to the left. The congestion of the membrane was most marked above the folds and there was some redness of the upper and posterior canal wall, but there was no sagging. A small polyp protruded through a perforation in the membrane up and anteriorily; this was removed and curettage done under ethyl chloride. There was considerable pain following the operation.

The patient was put upon hypodermics of pilocarpin hydrochlorate, gr. 1-10 to gr. 1-6 once and twice daily for ten days but without much effect except that the nausea gradually subsided, but the vertigo was not relieved. Potassium iodide was then given and pushed to the limit and under this some improvement in the vertigo was noticed. The patient's general condition improved and on July 13th, he was sent to Atlantic City with the hope that a more rapid result would be obtained. The iodide was continued. But three days later, July 16th, the patient returned to the Hospital complaining of severe pain in the ear and an increase in the vertigo. He was put to bed and carefully watched; the iodide was continued. The temperature and pulse showed nothing. The eye grounds were normal. There was still some nystagmus, but this was not so marked

as formerly. He had a leucocytosis of 15,900. The hearing was nil.

As the patient was apparently becoming worse, it was decided to operate for the two fold purpose of drainage and exploration. The mastoid cells were laid open freely and the region of the semicircular canals carefully explored, but the bony walls were intact. A small amount of pus was found in the antrum and there was some granulation tissue. From this time on there was slow, but continued improvement in the vertigo. The iodide was started again two weeks after the operation and given in large doses. The mastoid wound was purposely kept open until the latter part of September. Dr. Randall saw the patient at this time and suggested dropping the dose of iodide to ten grains and combining with it sodium bromide; this was done and the mastoid wound allowed to close. Improvement continued and the patient was able to take up his professional duties.

These three cases bear a close resemblance to each other. The question of a peculiar susceptibility to internal ear involvement following influenza suggests itself; though this may not be the case, yet the parts certainly must be more vulnerable at such a time. Case one gives a history of cold in the head, but might this not have been influenza? Cases two and three, give a positive history.

The rapidity with which the internal ear symptoms manifested themselves is noticeable; in the first case, thirteen days; in the second, ten days; and in the third, thirteen days were sufficient for the process to make an impression, though the initial lesion must of necessity have been earlier. Examination showed that the inflammation was most marked in the upper half of the membrane and the posterior canal wall.

In all these cases there was no extension of the inflammation beyond the antrum, the mastoid cells being free. It would seem as though the nausea and vomiting might have been caused entirely by the intratympanic condition as these symptoms subsided rather promptly after the pressure had

been relieved by paracentesis. The various tests mentioned as aids to diagnosis in labyrinthine involvement were useless in these cases; the patients were unable to raise their heads from the pillow during the acute stage of the inflammation.

To the writer, the diagnosis seems to be fairly clear. The complete loss of hearing. The very marked functional disturbance of the apparatus for the maintenance of equilibrium. The type of vertigo was distinctly rotary in all three cases. The nystagmus was characteristic in that it was produced by turning the eye to the well side and that it disappeared as the involvment of the labyrinth became more complete. Internal medication failed entirely to give relief.

Of course the question presents itself as to whether a long continued course of treatment would give results, but the distress was so great that the patients welcomed operative interference and it seems to be beyond question that the free drainage obtained by opening the mastoid greatly shortened the duration of the distress, and checked the tendency toward suppuration within the labyrinth.

While the function of the labyrinth was not preserved in these cases yet it is fairly certain that if the process had not been checked, suppuration would have supervened within the organ and a much more serious condition have resulted, so that the radical treatment seems to be justified in these cases if the condition does not yield readily to the milder measures.

A CASE OF FATAL SEPSIS AFTER FRACTURE OF THE TEMPORAL AND OCCIPITAL BONES.

By B. ALEX. RANDALL, Philadelphia.

On January 11th, 1908, there came to my clinic a man of 27 who had fallen from a height three days before, striking his head and having been taken unconscious to the hospital. When examined on admission to the Surgical ward he had fully regained consciousness and showed a lacerated stellate wound of the scalp exposing the bone near the left parietal protuberance. No fracture could be detected, the pupils were equal and responsive to light, there was no deviation of the eyes, no hemorrhage from the nose or ear, and he was able to move the arm and leg freely. There was a bruise over the left trochanter but no shortening of the leg nor apparent deformity. The scalp wound was scrupulously cleansed and sutured with silkworm-gut with drainage, and he was kept in bed. The maximum temperature following was 100.1, the urine normal and no other lesions could be discovered.

On dressing the wound next day and removing the drain, slight suppuration was found, the temperature was 99° and no disquieting symptoms were noted, but he complained of deafness of the left ear. Two days later the wound was healed except a small point at the site of the drain, his temperature was normal and his condition good. He was let up out of bed and, still complaining of deafness, was sent to the Ear Dispensary.

Aural examination showed hearing for the A-fork = 200 d.v.s. to be 25 and 19 cm. respectively, for the A = 50, 9 & 3 respectively, for the 2000-fork and the Galton whistle nearly normal with slight inferiority on the left, and the

bone-conduction slightly but equally exaggerated. The Weber test was not lateralized. His left canal was nearly filled with dry blood, there was a line of blood on the anterior-inferior quadrant of the drumhead and another smaller one back of the manubrium. Some redness and opacity of the drumhead, but no evidence of blood behind the membrane. It was gently antiseptically cleansed and a protective dressing applied after incision of the slightly bulging upper posterior quadrant had evacuated nothing. The next day he was made an out-patient.

On the 13th he still complained of deafness, fulness and some pain which seemed increasing, his temperature was 100°, with slight sanious discharge, and there was still much bulging of the upper-posterior quadrant. Free incision was again made, with only bloody evacuation, a wick wet with Carbolic glycerine and Atropine was inserted and his protective bandage renewed. As he had not improved the next day, January 14, he was re-admitted to the Hospital and put to bed, with hot Boric douching, protecting bandage and dry heat externally. His temperature was 100.1, pulse 80, respirations 20 and his eyegrounds normal. His bowels had been working freely, but he was given Calomel in fractional doses followed by a saline.

His temperature reached 102° next day with a minimum of 99°, but from that time grew more normal with relief of pain and moderate mucopurulent discharge. As it was normal on the 19th and all seemed going well, I acceded to his wish to go home and ordered him discharged to attend the Dispensary; but his temperature rose a little (100°) with renewed pain, and he was kept in bed. The next day it sprang from 99.2° to 104.2° at noon in spite of ice-cap, good bowel-evacuation and renewed antiphlogistic treatment; and with growing variation for the next few days maintained a maximum of about 105° in spite of spongings. No lung trouble could be found, the Widal and other investigations for Typhoid were negative, the leucocytosis moderate with nearly normal differential count, and free enteroclysis was

pressed in the hope that the matter was merely toxic. A chill occurred on the 22nd, and after another the fever reached 106.2°—falling 5° after a tubbing. There was no mastoid edema or tenderness, but slight pain in the ear and he was tender about the mastoid emissory and down along the jugular. He showed a little hebitude, with no photophobia, intolerance of noise or convulsion; eye-grounds still fairly normal; he vomited slightly once.

Consulations were held with my surgical and medical colleagues with rather negative results; jugular Phlebitis seemed present with a probable focus of Osteomyelitis, but expectancy seemed still advisable. On January 24th some mastoid tenderness was recognizable, the jugular was more tender, and after a third chill the fever had been 105°; so in consultation with Dr. Martin, operation was decided upon. The mastoid was explored without finding pus until the antrum showed a trace, the bone being inflamed in but slight degree. The sigmoid sinus seemed in good condition and was not opened; but the jugular was tied at the Omohyoid level, seemingly in healthy condition. There was slight shock, with temperature at the lowest for several days, 101° and pulse 104. He seemed slightly better next day, with temperature about 104°, however; and on the 26th the neck-wound appeared healed, the mastoid doing well and not too dry; but his respiration took on a noisy, hollow character with only pharyngeal edema to account for it, and there was stiffness of the neck and tenderness of the posterior muscles on the opposite, right side. The belated report from the blood-culture made some days before showed Streptococcus pyogenes in all cultures.

On January 29, after several days of septic course with temperature variations of 4 or 5°, his neck-wound began to suppurate and his left arm (near the elbow and the wrist) was red and swollen, threatening abscess. His breathing was so bad that intubation or tracheotomy had been several times considered, but only pharyngeal edema and oversecretion could be found, without fluctuation; and mere

scarification gave considerable relief. He was with difficulty brought through the following night, with much artificial respiration; but scarification again relieved his harassed breathing and no post-pharyngeal abscess could be found. His arm was now fluctuating near the elbow and several ounces of pus (streptococcus) was evacuated. His mastoid and cervical wounds were nearly dry and improving. There was much delirium at night and his mental condition was very bad.

On the 31st he seemed much improved, rational, with declining and steadier temperature but much pain in the back of the neck on the right. His leucocytes were still 12,600, his hemoglobin 67%, but the polymorphonuclear were 88%. The urine was dark, acid, with a trace of albumen and a few casts. The night brought return of bad breathing requiring his jaw to be forced forward or the tongue drawn out to permit respiration; no fluctuation could be found in the increasingly edematous pharyngeal wall. He failed through the day and died that evening.

The autopsy, restricted to the head, done 16 hours after death, shows the body fairly nourished with rigor complete. A wound of the left side of the neck and of the mastoid nearly healed: in the left parietal region a small wound hardly through the scalp, beneath which the bone is superficially red with a faint fissure-line tending downward and forward. On removal of the calvaria the meninges look and strip normally, the brain sinuses are in good condition and contain fluid blood, but the left sigmoid shows a small parietal clot adherent to its exposed outer wall. The parietal fissure can be traced down and forward through the squama into the floor of the middle fossa to a point one inch in front of the spinous foramen: a branch-fissure, curving back for half an inch, parallels the first and follows the tegmen in the axis of the pyramid. Each is a faint red line, with crepitus difficult to elicit and no evidence of Osteo-myelitis, altho there is slight darkening of the tegmen. The cerebro-spinal fluid is normal; but pus is noted in the foramen magnum and

traced forward on the left to the condyle, also slightly downward behind and in front of the vertebral column. This does not come from the posterior condylar foramen as at first appeared, but principally from the occipito-atlas articulation. A transverse fissure is present on each side of the posterior margin of the **foramen magnum** one and a quarter inch from the center, that on the right being discolored and having an osteo-myelitic area of a half-inch diameter surrounding it. This seems the starting point of the suppurative process in this vicinity. A probe in the condylar vein or the jugular encounters little clot and passes down to the point of ligation, where the occlusion is complete and the ligature in place. No communication can be proven between the pus in the occipital articulation and that in the neck-wound; but the probe passes nearly half way from each. No post-pharyngeal pus collection can be found but the pus is clearly tending to burrow downward.

The lesson of the case seems to be that in such an accident exploration should have been carried to the base of the skull, guided by the pain and stiffness on the right side and the threat of post-pharyngeal abscess, in expectation that no harm need be done by clean, skillful surgery, while every probable focus of infection should thus be drained if reasonably accessible.

A CASE OF THROMBOSIS OF THE LEFT LATERAL SINUS, FOLLOWED BY THROMBOSIS OF BOTH CAVERNOUS AND OTHER SINUSES OF THE DURA MATER. AUTOPSY. WITH ONE ILLUSTRATION.

By E. GRUENING, M. D., New York.

The occurrence of multiple thrombosis after the thorough removal of the thrombus from the lateral sinus and after ligation of the jugular vein is occasionally observed. It is certainly rare. This case is the first in the experience of the writer. An interesting feature is the presence of a proteus in the blood. Several cultures of the blood were taken in the course of the disease, and a micro-organism belonging to the proteus group, but which could not be more closely classified was found by Dr. E. Libmam, the bacteriologist of Mt. Sinai Hospital. A photograph of the patient taken several days before death shows swelling of the orbital tissues and of the whole head.

A. A., a boy 14 years old, of Russian parentage, was admitted to the ear-ward of the Mt. Sinai Hospital on February 3rd, 1908. The following history was taken by the house surgeon:

The present illness began suddenly two weeks ago with severe pain in the left ear. A few days later the ear began to discharge and the pain abated. The patient felt no further discomfort until two days ago when the discharge ceased abruptly and the pain recurred. The day before admission he had a distinct rigor lasting about ten minutes. Since the return of the pain there has been moderate fever and patient has suffered considerably from headache, not localized. The left drumhead has a large perforation and there is a discharge of foul-smelling pus from the ear. Right ear negative. The patient looks very sick. His face is cya-

notic. The pupils are unequal, the right being larger than the left. Both react to light and in accomodation. No palsies, no petechiae, no nystagmus.

Tongue dry, heavily coated. Exquisite sensitiveness to pressure behind the sternocleido-mastoid about one inch

below the tip of the mastoid. All movements of the neck are painful. There is one enlarged lymph node in the posterior crevical chain, also a few moderately enlarged inguinal lymph nodes. Chest well shaped with good expansion at apices and bases. Lungs negative, anteriorly and posteriorly. Heart:—Apex beat best heard in fifth space,

one half inch from the left nipple line. No murmurs heard at apex or base.

The knee jerks are slightly exaggerated the left more than the right. No Babinski. There is an ankle clonus on the left side, none on the right. There is a moderate Kernig on the left side.

On February 4th, one day after admission, the patient had a subnormal temperature of 96.4. This was followed by a severe rigor and a rise of the temperature to 105.4.

White Blood Count.....15,200

Differential Count,—

Polynuclears 90%

Large lymphocytes 7%

Small lymphocytes 3%

Eosinphiles 0

Ophthalmoscopic examination negative. Left ear: exquisite tenderness over tip of mastoid, also over whole mastoid region. The most tender area is over the emissary vein. No fluctuation. A blood culture was taken. On the afternoon of Feb. 4th, the patient who had a temperature of 105.8, pulse 148, respiration 32, was anaesthetized by gas and ether, and the following operation was performed on the left mastoid process.

The usual post-auricular curvilinear incision was made and supplemented by a transverse incision. The periosteum was detached and the mastoid bone exposed. The cortex was hard and apparently sound. The hardness, however, was only superficial and after a few strokes with the hammer the chisel encountered soft bone and entered a large cavity from which a considerable quantity of curd-like pus was evacuated. The pus came from the sinus itself, the anterior wall of which formed a slough reaching from the upper to the lower knee. After removal of the slough, several blood clots lying on the visceral wall of the sinus were removed. The posterior visceral wall of the sinus was thus exposed. The antrum was then opened and found

filled with cholesteatomatous material. The antrum and middle ear were cleared of these masses as also of granulation tissue and the carious ossicles. The left internal jugular vein was then exposed and ligated over the clavicle. The vein contained some fluid blood but its walls were thickened and discolored. The tributaries of the jugular vein were also ligated and the jugular vein was followed up to the jugular foramen and there cut off. The jugular bulb was exposed. It contained a disintegrated clot. which was removed. The upper knee of the sigmoid sinus and a part of the lateral sinus was then exposed, its thickened anterior walls were excised and a clot was removed which reached to within 1½ inches of the torcular. At this point blood flowed freely. The wound was dressed in the ordinary open way.

February 7th—Since the operation the patient has been running an irregular septic temperature ranging between 100.4 and 105. No chills. Pulse 120—140.

Report of the Bacteriological Department. A microorganism belonging to the proteus type is found in the blood, in the pus taken from the external auditory canal and in the pus and the thrombi found in the sinus.

February 8th—Moderate oedema of the scalp, forehead and the left upper lid.

February 9th—The oedema is more marked and extends also to the right eyelids. Patient is still septic, his temperature ranging from 100 to 104, and has a chill.

February 10th—This A. M. the swelling of the head and eyes has very much increased. Patient is very restless but fully conscious. There is a herpes nasalis and labialis. In the afternoon the temperature rose to 106. Pulse 158. Involuntary defecation and urination.

Ophthalmoscopic examination negative.

February 11—Patient still conscious. Temperature 105. Has had two chills. The oedema extends over the whole head. There is great hypersensitiveness of the whole body. Patient is restless and talks irrationally at times.

February 14th—For the past three days the temperature has ranged between 103.2 and 105.6. The head is enormously swollen. The accompanying photograph taken at the time illustrates this condition. Face and extremities are cyanotic. Respirations have increased to 50 per minnte, but are regular. Pulse 160. Patient is stuperous, can be roused with difficulty. No muscular paralysis of the extremities, no twitchings, no convulsions. Examination of the fundi negative.

February 15—Patient grew rapidly worse and ceased to breathe at 6.30 p. m.

Report of the Autopsy by the Pathological Department of Mt. Sinai Hospital:—

The wound looks necrotic. From the deep tissues of the neck a small amount of pus can be squeezed. There was found a purulent thrombosis in the following sinuses:

Both cavernous sinuses,

Right inferior and superior petrosal sinus,

Left superior petrosal sinus.

The right lateral sinus contained a recent non-adherent clot. In the cavernous sinuses the thrombi had entirely disintegrated and pure pus was found. From the cavernous sinuses the pus was traced into both orbits. The surface of the brain on the left side along the course of the lateral sinus showed a deposit of pus, but there was no meningitis. On section, brain negative. Lungs—Left lung contained a number of metastatic abscesses in process of formation. Heart—No acute endocarditis present. Spleen—Much enlarged, congested, pulp soft. No infarction. Other viscera not examined.

Remarks.

In this case, as in many hospital cases, the existence of an ear disease of long standing was not mentioned by the parents. They looked upon the disease as one sui generis and did not connect it with the affected ear. In the course of the operation it was shown that we had to deal with a

cholesteatoma that existed for a long time. The case furthermore demonstrates that very extensive plugging of the sinuses of the dura mater does not necessarily cause optic neuritis, for with almost every sinus thrombosed, the daily examination of the eyes showed that the discs were not choked. This indicates the probable correctness of the view held by many, that optic neuritis is due not so much to the obstruction of the veins as to an increase of intra-cranial pressure.

A CASE OF ACUTE SUPPURATION OF THE LABYRINTH, FOLLOWING ACUTE OTITIS MEDIA; OPERATION; RECOVERY.

By EDWARD BRADFORD DENCH, M. D.

While cases of acute suppurative inflammation of the labyrinth are not so very uncommon, the symptomatology of the affection is far from clearly defined. This is especially true of those cases which follow an acute inflammation of the middle ear.

I take the liberty, therefore, of reporting somewhat in detail the following case on account of the rather unusual manner in which the symptoms were presented.

The patient was a man sixty-five years of age, who about two weeks before I saw him, had an acute attack of grippe with an acute suppuration of the right ear. Spontaneous perforation occurred early, followed by profuse discharge. The drainage from the ear was insufficient, however, and eleven days before I saw him the right drum membrane was incised by a competent otologist. Free drainage was established, but the patient had suffered ever since the beginning of the attack, with severe pain in the head, together with pain in the right mastoid region. The patient also complained of inability to sleep. This sleeplessness, however, could not be attributed to the acute inflammation in the right ear, as he had been suffering from insomnia for some time prior to the acute otitis.

When I first saw the patient, I found him rather excitable, complaining of severe pain in the head, particularly upon the right side. There was some tenderness over the mastoid antrum, over the tip of the mastoid, and over the mastoid emissary vein. This tenderness was elicited only on firm pressure, and was not very severe. There was a profuse,

purulent discharge from the ear. Examination revealed a perforation in the antero-superior quadrant of the drum membrane, just beneath the anterior fold. A probe introduced through this perforation detected roughened bone. The aural discharge was not examined at this time, but it had been examined by the attending physician, who reported that the smears showed a diplococcus, and that no streptococci were present. A blood count had been made, showing a normal leucocytosis. No differential count had been made.

When I first examined this case, I was inclined to believe that operative interference would be necessary. The temperature of the patient was practically normal at this time, and it had been so for several days prior to my first visit. I saw the case quite frequently, however, and the mastoid tenderness disappeared. The discharge from the meatus diminished in quantity, but still retained its thick, purulent character. The patient was observed, at intervals, for one month. During this time the mastoid tenderness entirely disappeared, as did also the headache and sleeplessness. The patient was able to be about and take regular out-of-door exercise. When, however, he attempted any mental exertion he became very nervous and easily fatigued. Owing to the fact that the purulent discharge from the ear still continued—in spite of the fact that all mastoid tenderness had disappeared—I determined to open the mastoid. This operation was performed one month after I first saw the patient. At the time of operation the cortex was found to be perfectly normal, and fully an eighth of an inch in thickness. On opening the cortex the entire mastoid process was found to be broken down and filled with granulation tissue. The internal table was entirely destroyed, and the lateral sinus ran through a mass of granulation tissue. The wall of the sinus had become softened and the sinus was opened through the gentle removal of these granulations by means of the curette. Hemorrhage was easily controlled by means of gauze pack-

ing. The complete mastoid operation was done. A small epidural abscess was found just at the knee of the sinus, containing about half a drachm of thick yellow pus. After the mastoid operation the patient complained of severe pain in the head, which prevented him from sleeping, and required moderate doses of sedatives. I attributed this pain to the blocking off of the lateral sinus, but owing to the extensive exposure of dura, and the fact that the case had progressed about six weeks prior to the operation, I also feared the possibility of a collection of pus within the cerebellum. All unfavorable symptoms, however, gradually disappeared, and the patient was able to leave the hospital and return home.

The wound did well from the first, and in about five weeks after the operation had contracted down to a comparatively small sinus, through which a probe could be passed into the middle ear. The discharge from the ear ceased almost immediately after the operation, and the ear remained dry for about two weeks. At this time, the patient contracted a slight cold, when the discharge from the external auditory canal reappeared and persisted. There was free through-and-through drainage from the posterior wound to the canal, but, in spite of this, the discharge from the canal never completely disappeared. About five weeks after the mastoid operation the patient was suddenly seized with a severe attack of vertigo. In walking there was a tendency to fall toward the unaffected side. This vertigo was attended with nausea and vomiting. When the vertiginous symptoms first appeared, there was no nystagmus, but twelve hours later there was pronounced nystagmus, this being more marked when the patient looked toward the healthy side, although there was slight nystagmus on looking toward the affected side. This latter symptom, however, disappeared quite rapidly, and nystagmus could then only be elicited by looking toward the healthy side. The temperature was normal on the night of the first appearance of the vertiginous symptoms, and the next day it reached 101°. The patient complained of considerable headache.

It should be stated that immediately after the mastoid operation several blood counts were made, and at no time did the polymorphonuclear count rise above 68%, while on most occasions it was below 60%. Immediately following the acute vertiginous symptoms, the polymorphonuclear count rose to 74.5%, with a leucocytosis of 13,400. A smear from the wound showed a few bacilli, a few diplococci without capsules, and some large and small cocci. The discharge did not seem to exhibit any particular virulence.

The patient was seen in consultation by a prominent neurologist, who was at first inclined to believe that there was an abscess in the cerebellum. The reflexes at this time were somewhat exaggerated, and there were decided symptoms of meningeal irritation.

Knowing that all these symptoms could have been occasioned by an acute invasion of the labyrinth, I refrained from any operative interference. Forty-eight hours after the appearance of the labyrinthine symptoms the temperature became normal. The polymorphonuclear percentage dropped to 56.4%, and the leucytosis fell to 9,400. An examination of the fundus oculi simply showed some slight tortuosity of the veins. I might say that this same condition of the ocular fundus existed a few weeks after the simple mastoid operation had been performed. As the examination was in each instance made by the same man, he reported that there had been practically no change in the fundus oculi. Owing to the fact that the temperature had fallen, and that the blood count showed no indication of absorption of pus, and also, as the patient's symptoms were gradually disappearing, I decided to defer operation.

The patient gradually, steadily improved for the next six weeks. At the end of this time the mastoid wound had entirely closed, with the exception of a small sinus at the upper angle of the wound which led directly into the middle ear. The discharge from the ear, however, continued, and the probe introduced through the perforation in the drum membrane, still encountered roughened bone. An examina-

tion of the discharge from the ear showed streptococcus capsulatus.

During the six weeks following the vertiginous attack, the symptoms of disturbed equilibrium steadily improved. The vertigo now was so slight as to cause the patient but little annoyance. The nystagmus entirely disappeared, as well as the pain in the head, and the patient was able to sleep well at night. On account of the persistence of the discharge, however, I determined about seven weeks after the attack of vertigo, to perform the radical operation. At the time of the operation I found a small eroded area in the horizontal semi-circular canal. The lumen of the canal was opened, and a small amount of turbid fluid escaped. The oval window was then examined, and in order to establish free drainage of the labyrinth, was enlarged. In enlarging the oval window, a scale of necrotic bone was removed from the promontory, uncovering the lower and a portion of the second turn of the cochlea. The interior of the cochlea presented a reddish appearance, as though some granulation tissue was present there, although no pus could be detected Through drainage was established between the opening in the horizontal semi-circular canal and the opening in the vestibule below the **aquaeductus Fallopii.** The posterior wound was completely closed, with the exception of a small opening at the lower angle, where a gauze drain was inserted. The external auditory meatus was enlarged by cutting a tongue-shaped flap from the concha, thus securing complete drainage of the entire cavity through the meatus. A meatal skin graft was applied.

Since the radical operation the patient has progressed favorably. The dizziness has entirely disappeared, there has been no nystagmus, and at the present time the radical cavity has completely dermatized.

The examination of the ear after the appearance of the vertiginous symptoms was interesting. A moderate whisper was heard, two weeks after the vertiginous attack, at seven feet from the ear. The tuning-fork placed on the forehead,

was heard better on the affected side, but the absolute bone conduction was diminished on both sides. The upper-tone limit was lowered to 4 Galton on the affected side. One month after the attack, and before the radical operation, a moderate whisper was heard at 5½ feet in the affected ear. Bone conduction was about equal on both sides, but the tuning-fork placed upon the forehead, was referred to the affected ear. The lower-tone limit in the affected ear, was elevated to 512 double vibrations per second. The upper-tone limit was 4 Galton. The tone limits on the unaffected side, were normal.

After the operation, moderate whisper was heard at a distance of 6½ feet, and the vibrating tuning-fork placed on the forehead, was referred to the affected ear, although absolute bone conduction on the affected side, was slightly diminished. The lower-tone limit on the affected side was 512 double vibrations, and the upper-tone limit was 4.5 Galton.

This case to me was interesting from several points of view: In the first place, the appearance of labyrinthine symptoms, in spite of free drainage of the middle ear through a posterior opening. We usually expect to find labyrinthine symptoms developed only in cases where there is some obstruction to drainage. In this case, the middle ear was draining freely, not only through the mastoid opening, but also through the external auditory meatus, but in spite of this, there was an invasion of the labyrinth. Whether this invasion took place through the oval window, and the carious area in the horizontal semi-circular canal occurred secondarily, or whether invasion took place through the horizontal semi-circular canal, can only be a matter of conjecture.

A second point of interest was the relative short duration of the acute labyrinthine symptoms. At the end of forty-eight hours from the inception of these symptoms, the temperature was normal, and remained so in spite of the fact that the labyrinth was the seat of suppuration. The gradual disappearance of the labyrinthine symptoms, such as vertigo and nystagmus, is also a matter of interest.

When we come to examine the tuning-fork tests, the fact that the tuning-fork held upon the forehead was always referred to the affected side, is a phenomenon rather difficult of explanation. With destruction of the labyrinth, we would naturally expect that the tuning-fork would be referred to the opposite side, and that bone conduction on the affected side would be greatly diminished. My case shows, however, that five or six weeks after the labyrinthine symptoms first appeared, the tuning-fork placed upon the forehead, was still referred to the diseased ear, and that the upper-tone limit was not greatly lowered. Bone conduction, however, on the affected side was slightly diminished. Even after the radical operation, we still find the tuning-fork reaction somewhat confusing. The vibrating-fork placed upon the forehead, in the median line, was still referred to the affected ear. Bone conduction on the affected side was somewhat diminished,—not absolutely lost, while the upper-tone limit was only reduced to 4.5 Galton. The elevation of the lower tone limit would be simply indicative of the middle ear lesion, and would have no bearing upon the labyrinthine condition.

It is a question in this case, whether it would have been wiser to have operated when the labyrinthine symptoms first appeared. From the satisfactory outcome of the case, I am inclined to think that I pursued the preferable course. Had I operated at the time of the acute symptoms, I rather think that I might have opened up a fresh avenue of infection in the labyrinth. Had the fever persisted, I should naturally have exposed the horizontal semi-circular canal and the inner wall of the middle ear at once by the radical operation; but in the absence of febrile symptoms, I felt that it was better to wait until the diagnosis of labyrinthine involvement could be definitely established. Had I operated within the first twenty-four hours after the appearance of the symptoms, I should probably have explored the cerebellum, as the symptoms pointed very strongly to involvement of the cerebellum. Such an exploratory operation would, of course,

have been unnecessary, and might have been followed by serious results.

While it is impossible to lay down any definite rule in regard to these cases, I believe that if the temperature does not rise above 101° or 102°, it is well for us to wait for a certain interval, and see if the labyrinthine lesion will not be self-limited. If, however, the temperature continues to rise, it is necessary to operate immediately, as then the only hope of preventing an extension of the inflammation to the cranial cavity is by prompt operation. This has been demonstrated by Jansen and others.

I think the rule should be, therefore, that with labyrinthine symptoms and pronounced elevation of temperature, operative interference should be at once instituted. With labyrinthine symptoms, however, with little or no febrile movement, it is wiser to wait for a few days, at least, before opening the labyrinth.

A CASE OF DOUBLE OTITIS MEDIA PURULENTA CHRONICA WITH EXTRADURAL AND INTRADURAL ABSCESS, EXTENSIVE EXPLORATION OF BRAIN, DOUBLE EXENTERATION, RECOVERY WITH GOOD HEARING.

By G. A. LELAND, M. D., Boston.

Mr. B—— G——, clerk; single, 17 years old; admitted to B. C. H. Oct. 1, '06, with the following history:

Family history negative. At two years of age had measles; slow fever 7 years ago. Has had suppurating ears about 6 years with moderate deafness for about 3 years; no difference in ears. Has been under the care of a local aurist for a year and a half for this purulent discharge. About the first of Sept. complained of headache which seemed progressively to increase. Always had been taciturn, perhaps on account of his difficulty of hearing, but during this month before admission seemed to be more sober and quiet. The latter part of the month frequently asked his associates what might be good for severe headaches. About the 23rd or 24th of Sept. he was found at his business place holding his head in his hands because of the severe pain.

On the 25th or 26th complained of nausea and left his desk to go to the lavatory; was found some time later asleep in the corner of an adjoining room: somewhat dazed and stomach-sick. Was sent home by the boss as he did not look well enough to work. In the A. M. he had vomitted yellowish greenish material. Both the evenings of 24th and 25th he was nauseated on coming home.

On the 26th his physician was sent for and because of his terrific headache and gastric irritability, instituted treatment for acute indigestion. Next day he was no better and

his mother went to the doctor's who sent back a dose of calomel.

On the next day, the 28th, he was visited by his physician; temp. 104° F.; pulse 120. He had evacuated dark greenish stools, and the physician changed his diagnosis to that of typhoid fever. There were no eye symptoms. He was slightly delirious at night, which was attributed to his temperature.

On the first of October he was visited by his physician who found his temperature again 104° F., but the pulse only 78. The nurse reported that he had two convulsions that A. M. During the physician's visit of about 15 minutes he had two more convulsions. The doctor noticed that they started in the right side of the face, that the twitching involved the whole right face including the chin, and was towards the right, and then extended to the right hand and arm. If they were more severe they became general. There was no stiff neck but the face had a slight cyanotic appearance. There was no vertigo, the main symptom complained of being headache. The tongue was furred and protruded to the right. He was sent into the City Hospital and admitted to one of the medical services, and the following observations were made:

Patient was of full adult development; a strong healthy base ball player. Talked rationally but thickly, somewhat sluggish mentality, slightly deaf. No pain, considerable prostration, good respiration; eyelids half closed, pupils dilated, equal and react, the right more sluggish, internal strabismus of right eye, no photophobia. Tongue covered with whitish dry fur, protrudes to right, edges clean. Scanty brownish, thick discharge of very foul odor from both ears, worse on right. No mastoid tenderness, swelling nor oedema. Neck was somewhat rigid, slight retraction and tenderness. Pulse 92, irregular in rhythm and force but of full volume and good tension. Heart was negative except there was a slight systolic murmur at apex and accentuation of aortic second sound. Other organs negative. Re-

flexes were tested and it was found that knee jerks were absent. There was very slight if any double Kernig; right perhaps slightly more marked than left. No Babinski nor ankle clonus. During the day he had 5 convulsions which began in the right side of the face, twitchings of the mouth and chin and eye lid. Soon after the right hand was involved and then the right arm, and if further involved or increased in intensity then the right leg. There was partial paralysis of the right side of the face so that the mouth could not be drawn to the right so well as the left. Right hand paralyzed. No nausea, nor vomiting. He had complained of being struck on the head, and percussion over the left temporal bone caused him to wince.

The day after admission, Oct. 2nd, he was seen by the Aural Service, in connection with a neurologist, Dr. J. W. Courtney, about noon. Had 3 severe convulsions this A. M., generally as above described though not involving the leg. Left side of the face twitches at times, and being rather restless left leg thrashes round considerably in bed. Moves right arm somewhat but right hand is paralyzed and there is anaethesia below the wrist; left side normal. Is rational and talks some between convulsions. There is no pain. Slight retraction of the head. Pulse below 70, cerebral in type. Retention of urine required catheterization; constipation; unable to swallow on account of twitching of face. Certain investigations were set on foot. Blood count found to be 17,500 whites.

About 10.30 in the evening symptoms had markedly increased, pupils were widely dilated, right larger than left, and reacting less; nystagamus with rotation to the right, right homonymous hemianopsia. Marked paralysis of the right face and arm but upper part of the face less involved; with convulsions, head drawn far over to right, unconscious. Examination of the ears showed the left drum head nearly absent except a small remnant, with granulations and caries in the middle ear; foul purulent discharge; no prolapse of the canal walls, no mastoid symptoms. The right ear was

about the same except discharge was much more copious and more foul.

Operation at 10.30 P. M., Dr. Courtney present, very small amount of ether necessary; the usual mastoid incision was made and the process found to be eburnated; no diploëtic or pneumatic cells, which is quite frequently the case where there is extension to the cerebrum. A small antrum was found full of granulations with caries of the tegmen. The external incision was continued straight upwards 4 cm. and the squamous portion of temporal bone uncovered. The bone was removed forward over the tegmen tympani, through which was found a small defect leading to the middle fossa and giving exit to sero-pus. The tegmen and part of the contiguous squamous portion was removed, and a large amount (probably 25 c.c.) of greenish sero-purulent fluid of very foul odor was evacuated. (Pathologist reported streptococcus). Dura was found to be thick and opaque and was carefully explored for a perforation but none was found. Hence was not opened. It was covered with a fine layer of reddish granulations. The inner surface of the fossa was searched with a probe and dura found adherent a short distance from this area. The wound was dressed and patient made good ether recovery.

Next A. M., Oct. 3rd, it was reported that convulsions had been present at frequent intervals during the night, rather more general than before the operation; no nausea. During the daytime there was a slight convulsion at 7.40. 8.25, 11.30 A. M. of short duration. He seemed somewhat better than the day before, retaining nutrient enemata but towards noon convulsions became much more frequent and severe. After consultation with Drs. Prince and Thomas, of the Neurological Dept. who diagnosed cerebral abscess, he was brought to the operating table at 1.30 P. M. At this consultation patient was unconscious most of the time. Knee jerks, Kernig, and Babinski all absent.

The wound of the previous day was unpacked and continued higher on the temporal bone and more of the squam-

ous portion removed (about 3 cm. in diameter). A horizontal incision was made through the dura which did not bulge nor pulsate. A small amount of cerebro-spinal fluid escaped. A curved medium sized trocar was used for exploration and was passed into the brain to a depth of 6 to 8 cm. in nine different directions, care being taken not to tap the ventricles. There was no pus found. Patient left operating table with pulse 112, in good condition. Medication ordered was, nutrient enema every 4 hours; morphia ¼ gr. every 4 hours, to try to control convulsions; and strychinia 1-30 gr. every 4 hours, for the heart. During the night till 7 o'clock in the A. M. (there was one convulsion at 8 P. M. involving the right face, hand and shoulder, lasting a minute), till 7.45 P. M. there were 49 spasms noted by the special nurse. None of them involved the leg. Many of them involved only the face. At 7.40 P. M. there was one convulsion noted as general and at 7.45 a slight one of the face; at 8, a more severe one, general, and from that time to 5.10 P. M. of the 4th there were 54 spasms noted; some of them slight; and he was quiet between spells most of the time. One of them was noted as very severe involving the whole of the right side. There was slight delirium, and at 4.20 P. M. one lasting one and a half minute extending to left leg. Ether was administered during the convulsions and it was amusing to see the patient reach for the ether cone when he felt the approach of a spell. During this day he slept considerably between seizures and took a good deal of nourishment by the mouth.

On the next day, the 5th, there was marked improvement in mentality and he had but 3 convulsions. Was rational most of the time, complained of no pain, slept considerably, took nourishment when roused. One convulsion only extended to the right arm and was severe; and on this day the temperature fell to 97.8° and pulse to 90 in the A. M. In the evening, temperature normal and pulse 86. Oct. 6th there were but four convulsions, the last one at 5.40 P. M. which was the last real one of his illness. On that day

Ms. B. 3

Date of Observation | Oct. 2. 06

Date of Observation |

Date of Observation |

Diagnosis

Nov. Dec.

DAY OF MONTH | 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22

DAY OF DISEASE

TIME

TEMPERATURE. 107° 106° 105° 104° 103° 102° 101° 100° 99° 98° 97° 96°

Operation Enterocolitis Acute

Operation, R. Inguinal

Operation, L. Inguinal

Acute diarrhoea commenced

Operation, R. Femoral

Operation, L. Scapular

Operation, R. Inguinal

Operation, R. Radial

Acute

Skin graft. R. arm

Discharged to O.P.D.

PULSE. 150 140 130 120 110 100 90 80 70 60

RESPIRATIONS. 50 45 40 35 30 25 20 15 10

175 cc White

resumed control of his bladder, and shook hands with his attendants but refused some of his medicines.

Oct. 7th there were no convulsions, but at 6.20 on the A. M. of the 8th he suddenly developed Cheyne-Stokes respiration. During the apnoeic period there were slight twitchings of the left eyelid towards the nose, then involving the temple. At 6.45 temperature was 96° F. by the axilla and groin.

The wound was dressed daily till the 7th and there was considerable escape of cerebro-spinal fluid from the dural wound which now ceased.

During the next two days he was inclined to be somewhat delirious, trying to remove his bandages; but he had no convulsions except possibly a slight twitching of facial muscles on the left side which were possibly voluntary. Took nourishment well; paralysis of the right side had disappeared. Heart stimulants continued till today, now omitted.

9th, wound granulating in very fast. Sleeps most of the time, easily roused, slightly delirious, the right pupil slightly larger than the left, and fundi normal. Yesterday was able to sit up in bed three quarters of an hour; takes much nourishment. Still trying to remove dressings. Today sits up a half hour and very comfortable; sleeps naturally most of the time. Tore his dressings completely off once. Foul copious discharge from right ear.

12th, sat up one and a quarter hours but is drowsy and sleeps a good deal of the time; however, slightly irresponsible, requires watching. Out of bed and walked out into the corridor. Removed his dressing today. Sleeps without the use of drugs.

13th, cross and cranky and tore off bandage; generally working at it. Was out in the open air on the bridge one and three quarters hours in a wheeled bed.

14th, took solid food for first time (chicken); well relished, slight ptosis of right eye more marked in P. M.. Drowsy, cranky and cross when awake; out of doors two hours on wheeled bed.

15th, sat up in a chair and was out of doors three and three quarters hours, comfortable and less cranky. Tore off bandages.

16th, wound has been dressed daily, is granulating in very well, no escape of cerebro-spinal fluid after the 7th. Appetite variable as well as disposition. Still is improving rapidly. Out of doors as much as weather permits.

18th, was able to walk to the lavatory very steadily, can read magazines, etc. Pulse remained about 70-80 for the past 13 days; temp. normal or below especially in the A. M. on the 10th it reached 95.5° F.

21st, sits up most of the time, entertains callers, diet much more generous. About 9 o'clock in the evening began to be quite morose and had a crying spell, seemed very childish. This is the first appearance of such a phase.

22nd, the lachrymose condition continued through the day.

23rd, still lachrymose and childish. Somewhat restless. Sleeps and eats exceedingly heartily.

27th, he was etherized in order to explore the right ear and do a radical on the left. A large amount of caries was found in the right. Marked cleanliness of the left middle ear; the radical was postponed.

Oct. 30th, parents' permission being given, operation on the right mastoid. The usual curvilinear incision was made from the temporal line to the tip of the mastoid and skin and superficial muscles dissected up from the fascia. Then leaving the attachment in front, incision was made through the fascia down to the bone along the posterior edge of the mastoid upward and backward about 6 cm. then upward about 2½ cm., then forward along the temporal line to the posterior canal wall,—to make a long tongue-shaped flap of the periosteum and tissues above it, the attachment of the base being along the line of the anterior mastoid wall. The process partly pneumatic and partly diploëtic was removed; the antrum cleaned of its granulations and carious walls by the curette. The anterior mastoid wall was not removed

but the posterior edge of the flap was passed downward into the excavated mastoid cavity, the tip being anchored in the aditus by gauze wicks and the body of the flap being carefully adapted to the anterior mastoid wall. The bone being very red and inflamed hemorrhage was profuse but ceased on packing.

Nov. 2nd, right wound dressed. Flap remained in good position.

Nov. 4th, right wound dressed, considerable foul odor, granulations unhealthy in appearance. Thoroughly irrigated, slightly curetted, and again packed. The left side discharging freely, a sinus running down to the dura through the almost entirely closed-in mastoid wound; explored with a probe. Redressed. Patient very much improved both mentally and physically.

Nov. 8th, on account of the copious discharge of pus, the wound on the left side re-opened under ether and above the temporal line a large semicircular sequestrum consisting of part of the squamous portion of the temporal bone posterior to and above the previous opening was found to be loose and removed. This was about 5 by 2 cm. in extent and with ragged eroded edges. Under the dural incision was found a depression 1 cm. in depth extending directly into the brain, containing some thick cheesy pus. Some of this was removed with a director; and the ragged edges of the perforation through the squamous were removed and smoothed down to healthy bone. Gauze wicks were placed through the dura into this purulent mass and pads and bandages gently applied. Good ether recovery.

Nov. 10th, redressed, wicks removed from the intradural cavity; and it was interesting and rather surprising to see the pulsations of the brain push out a mass of inspissated cheesy pus about the size of, and one half the depth of a thimble, followed by about 3 drachms of liquid pus. Wicks again reinserted and wound dressed. (Pathologist reported streptococcus and colon bacillus).

Nov. 16th, redressed and shown at the meeting of the

New England Otological and Laryngological Society, a clean cavity about ½ cm. deep and about 1½ cm. in diameter being shown through the dura. Patient's disposition has changed very much; instead of being quiet, morose, and taciturn, he has become just the opposite; is pleasant, genial and inclined to be garrulous.

Nov. 22nd, operation on the right ear. Radical. Old wound opened. Granulations partially removed. Periosteal flap was incised at its reflection posterior to the auricle and separated from the anterior mastoid wall, its internal attachment being carefully preserved. The posterior bony canal wall was now removed down to the facial ridge and middle ear. The hammer was found but the anvil was not surely identified. The periosteal flap still being attached interiorly was bent backward so as to diminish the size of the posterior excavation. On account of the previous foulness of the granulations of the middle ear, primary dermatization not attempted. Long ether recovery, with some delirium.

Nov. 24th, redressed.

Nov. 27th, redressed, profuse discharge from right ear, granulations healthy; left ear not discharging.

Dec. 4th, skin graft; right ear. Granulations removed from the middle ear; a T-shaped incision through the posterior cartilaginous wall; flaps anchored above and below. Thiersch grafts removed from the flexure of the elbow and fixed down on the granulated middle ear surface. Posterior wound stitched up. Cavity posterior to periosteal flap nearly granulated in.

Dec. 7th, gauze removed. Grafts have taken satisfactorily. Few granulations cauterized with $AgNO_3$ 50%

Dec. 22nd, restored to normal condition of mind and body; only slight discharge from right ear and almost none from left. Discharged to the Out Patient Department. Hearing not tested by instruments, but much better than before operation. Left ear has few granulations and posterior wound not yet fully healed. Thought that out door exercise and home life would be more wholesome than hospital care, two and two thirds months after admission: discharged.

Mar. 25th, '07, wound has been dressed up to the present time frequently at the Out Patient Dept., right ear dry and dermatization complete. The left mastoid wound has broken down and a fistula of 2 cm. or so in depth can be explored by the probe. Not much discharge. Patient has been very well as to general health and mental condition. Is practically as well as before his illness. On this day a radical operation on left ear was performed. In the upper part of the mastoid wound was found a fibrous mass apparently covering the dura; no bony sub-stratum could be felt. This was at the site of and below the previous opening through the dura. The bony tegmen of the antrum and middle ear having been reproduced, was thoroughly smoothed and cavity thoroughly cleaned.

Apr. 4th, skin graft; T-shaped incision being made through the posterior canal wall. Patient being such a marked descendent of Esau, the only skin without hair follicles was found on the left lateral gluteal region.

Apr. 12th, graft took well. Cavity in general well dermatized. Slight perforation through the mastoid wound.

Apr. 16th, discharged to Out-Patient Dept. Throughout the summer of '07 more or less treatment was necessary at the Out-Pt. Dept. to insure complete dermatization of this cavity.

May 17, '07, was examined at the office. Right ear found to have slight discharge with one granulation which was cauterized. Left ear dry with epithelial and ceruminous debris which was removed. The hearing was, right 16 inches, left 18 inches for Politzer's acoumeter. He says he hears better than he has for a number of years. He has no vertigo and no seizures of any sort, and is about to leave for New Orleans to join that city's base ball team, on which he had been hired for the season.

It has seemed worth while to put on record this case as one of extensive lesions of aural origin, of dangerous complications, of almost lethal termination, of restoration to health through multiple surgical interference, of apparent innocuousness of extensive brain exploration, and of resultant good hearing after ablation of both middle ears.

In this case, as in others in the writer's experience, exploration of the brain under strict antiseptic precautions seems to have done no injury. In one case, several years ago, where the cerebellum was prodded in a similar manner in five or six different directions, at the autopsy three days later, the tracks made by the trocar were carefully looked for, and found to consist of fine red lines only, with no macroscopic disturbance of contiguous substance, and this in the cerebellum where the blood supply is much greater than in the white substance of the large brain. One of them rather larger than the other reached to within ½ cm. of the abscess.

Most remarkable in this case under review was the appearance thirty-seven days after the brain exploration of a mass of inspissated and liquid pus, in the left temperosphenoidal lobe, of such large size, and giving rise to no disturbance of temperature, pulse, or speech. And the question arises whether it was a latent abscess through which the trocar passed and which afterwards found its way to the surface by extension; or whether it was of tubercular origin, though no tubercle bacilli were reported; or whether it was a local collection caused by infective material carried in from the outer surface of the dura by sterile instruments. This latter alternative may well be probable; and the size of the mass may also be accounted for by the extensive laceration of the cortex at this point made by passing the trocar in so many different directions. However, the cavity was completely obliterated in a week leaving no trace. And if it was thus caused by infection, still the question arises why the same infection did not follow one or more of the trocar tracks deeper into the brain substance.

The treatment of this case extended over a period of upwards of six months, but it seems satisfactory that after nine etherizations, (eight for operation and one for exploration) the patient came out of it so well, thanks to his resistive power.

I am much indebted to the neurologists mentioned for their timely suggestions, and to Dr. Cahill, the house officer who assisted me in the preparation of this report.

REPORT OF A CASE OF DOUBLE OPTIC NEURITIS AND BILATERAL PARALYSIS OF THE EXTERNAL RECTI MUSCLES OF THE EYE, WHICH DEVELOPED AFTER AN OPERATION FOR MASTOIDITIS, DURING WHICH THE LATERAL SINUS WAS TWICE WOUNDED AND WAS FOUND TO CONTAIN FLUID BLOOD. COMPLETE RECOVERY.

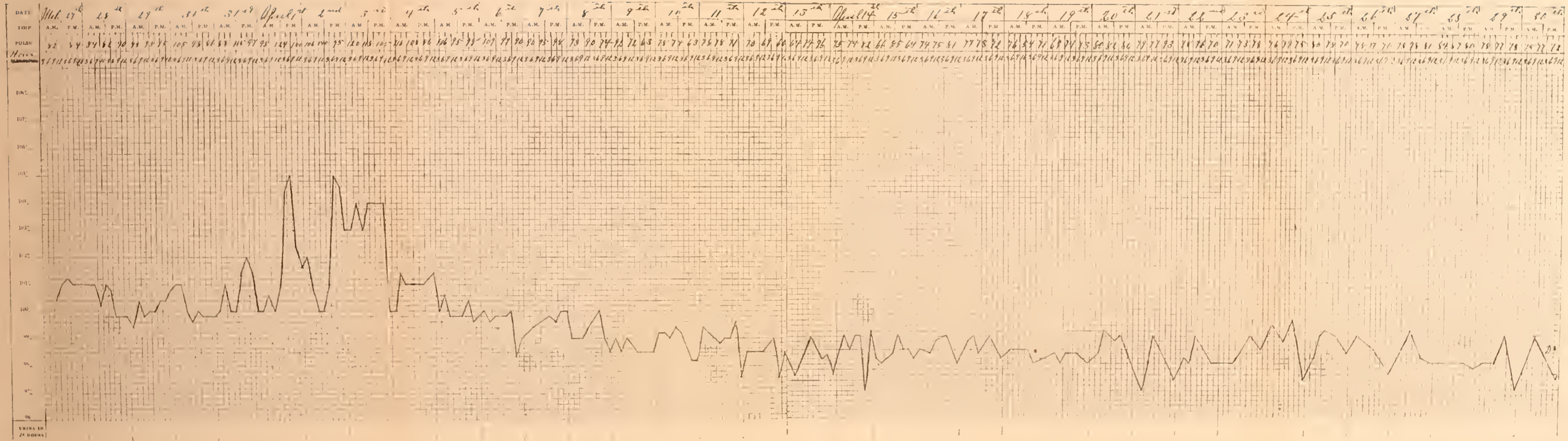
By CHARLES J. KIPP of Newark, N. J.

C. C. a girl of 9 years of age was admitted to the Newark Eye & Ear Infirmary on March 27, 1908.

Her family history contains nothing of importance. With exception of Scarlet Fever which she had four years ago, she has had no disease other than ordinary colds. She has an intermittend discharge from her left ear since she had the Scarlet Fever. The otorrhoea has never been profuse and for months the ear has been dry. Two days previous to her admission to the Infirmary, she had a convulsion which was followed by a paralysis of the whole right side and lasted one day.

A physician who saw her the day after the convulsion was unable to detect remains of the rightsided paralysis.

On admission I found the patient to be rather small for for her age and very thin. The left ear contained a small amount of pus which was not offensive; a perforation below and back in the drum membrane; no garnulations. No signs of mastoiditis were present; she complained of some headache, but otherwise felt perfectly well. The eye-grounds were normal. The temperature was 100.3. The urine was free from albumen and sugar. She was kept for observation. The treatment consisted of thorough syringing with warm normal salt solution and inflation of the drum cavity. During the following six days the temperature ranged between


NAME
FEVER CHART
FEVER CHART
DATE
TIME
PULSE
Hours
A.M.
P.M.
URINE IN 24 HOURS

98.5 and 102. She was free from headache and complained of no pain anywhere. Her appetite was good, she slept well. The otorrhoea almost entirely ceased under cleansing. On April 1, the temperature rose suddenly to 105. She complained of headache. A careful examination failed to account for the rise of temperature. There was no sign of mastoiditis. The external canal was of normal size, there was no tenderness over any part of the mastoid. An examination of the blood showed a moderate leucocytosis with polynuclears 83%, eosinophiles 9%. A blood culture was negative. The temperature fell to 100 in the evening and did not rise again till next day when it again reached 105. No symptom of mastoid disease could be discovered. Lumbar puncture showed clear fluid under moderate pressure. On the third (next day) the temperature had reached 104, when I made an explorative operation. Under ether I made the usual operation for opening the antrum. The soft part over the mastoid and the cortex of this process were normal in appearance. The bone was not soft. The antrum was situated rather deeply, it contained some livid granulations but no pus. Below the antrum the mastoid cells contained some thick greenish pus, and over the lateral sinus I found a large collection of foul pus, the bone covering the sinus carious and very soft. While slowly and carefully under good illumination I was uncovering the sinus near the bulb, there was a great gush of venous blood which was arrested by pushing iodoform gauze between the sinus and its bony covering. While removing the bone near the upper knee of the sinus by means of a rangeur and without using force or pressure, the walls of the sinus ruptured and here again we had a profuse venous hemorrhage which was arrested by pushing gauze between the sinus and the bone. When the hemorrhage was arrested, which took some time, I completed the operation by exposing the sinus between the wounded points and found it normal in appearance. I removed the entire cortex of the mastoid and resected the tip. The wound was now closed and dressed in the usual

way. During the past twenty-five years I have uncovered the sinus many times, but never before have I met with the accident recorded here. That the sinus wall was abnormally thin or very much softened is very probable.

The girl was put to bed, slept well and on the day after the operation said she felt well and the temperature did not go above 101⅖. During the following 13 days the temperature varied between 98 and 99.6. She was perfectly well and wanted to get out of bed and wanted more food. On April 17 while apparently convalescing, I noticed that she had a convergent strabismus of left eye, and on examination of the eyes I found that she had a well marked choked disc in both eyes, with fulness of retinal veins and small arteries. The squint was due to a paresis of both abducens nerves. The wound was doing very nicely and the girl was gaining in flesh and doing well. Since then she has been in good health. The temperature varied as it will with children in ordinary health, from 97½ to 101⅕, but as a rule has not been above 99. Her pulse is good and usually about 80. At the present time June 19, the wound has entirely closed. The ear is dry, the perforation is closed. The optic neuritis has disappeared. Her vision is almost normal. The squint is scarcely noticeable. An examination of her blood made within 2 weeks shows still a slight leucocylosis with 81% polynuclear and 4% eosinophiles.

I have seen a number of other cases similar to this in consultation with other physicians and in all except the one reported by Eagleton, the patients made a complete recovery.

I have been unable to make a thorough search for similar cases in literature; but that such cases are not very common is shown by the following cases recently published.

Hegener (Graefe-Saemisch, Handbuch der gesammten Augenheilkunde II Theil, IX Band, XVI Kap., p. 123) has reported a case in which optic neuritis developed 9 days after operative evacuation of the subarachnoidal space. Complete recovery without further surgical intervention.

Hansen (op. cit.) has seen a case in which during convalescence from mastoid operation after ligation of the internal jugular vein, optic neuritis and other signs of cerebral irritation appeared, probably the result, he thinks, of abnormal condition of the venous blood vessels whereby the collateral channels available were in a more unfavorable condition than usually.

Kőrner (op. cit.) has reported a case of bilateral optic neuritis and paralysis of the abducens after a mastoid operation which entirely recovered without a further operation although such had been urgently advised by the examining ophthalmologist.

Knapp has seen a case in which well marked optic neuritis developed after evacuation of otitis brain abscess.

Schlegel has reported: A case of bilateral thrombosis of the lateral sinus and ligation of one jugular vein. (Archivf. Ohrenheilkunde, Band 69, 3 & 4 Heft, p. 176.)

A woman 25 years of age, first operation, left side Oct 19, secondary operation, same side Nov. 4. Ligation of internal jugular vein right side, Dec. 5. Eyegrounds normal Dec. 22, optic neuritis right eye, Jan. 6. Optic neuritis both eyes Jan. 13. Optic neuritis, paralysis ext. rect. & oblique muscles, Jan. 15. Eyes normal end of February.

Dr. Harry Friedenwald, reported the following case at the 1908 meeting of the Ophthalmological Section of the American Medical Association .

A colored woman 22 years of age was operated for abscess of mastoid March 3. The lateral sinus was exposed for about half an inch, part of it was found covered with granulations, it was likewise exposed at the tip of the mastoid which was one large cell filled with pus. After packing the latter cell and withdrawing the packing there was a profuse hemorrhage from the lateral sinus although no violence had been used. It was controlled by packing with iodoform gauze. Her temperature at the time of the operation was about 99, pulse 80-98. On the following day the temperature was irregular reaching 103 6-10 on the fourth day after

the operation, while the pulse dropped on the second day after the operation to 64 and remained below 70 for several days except when the temperature was very high and the pulse rose to 100. On the fifth day (tem. 98.8 to 100.1) abducens paralysis set in and he found a mild optic neuritis. From this period the temperature remained normal, though the pulse continued slow during the entire first week, but the neuritis increased and rapidly became a typical choked disc with hemorrhage in both eyes, more marked in the left. Seven months after the operation he found a very little swelling of the disc, the veins slightly tortuous but not very full, the arteries somewhat narrow, the color of the disc pink and margins obscured. Vision, R. E. 16-30 L. E. V. 10-100. He considers the diagnosis of serous meningitis as most probable.

W. P. Eagleton, Archives of Otology, Vol. XXXV. p. 91. Boy 9 years of age, March 8. Chronic Otitis Med. pur. left side, vessels of left optic disc rather full. Operation March 21, ligation of left internal jugular vein, thrombosis of left lateral sinus; half hour before operation no optic neuritis. Day after operation marked double optic neuritis. March 23, retinal veins enormously dilated and tortuous; arteries small; numerous hemorrhages in retina. March 27, intense double optic neuritis; April 10, totally blind. Death June 6, 2½ months after operation on sinus and ligation of internal jugular vein.

Autopsy:—Left lateral, the torcular, inner one fourth of right lateral, nearly the whole of longitudinal sinus thrombosed. Hernia cerebri involved nearly whole of left lateral lobe of cerebellum; extending from it was an area of softening involving the left lateral portion of pons. Cross section in upper part of medulla showed in median line of the floor of fourth ventricle hemorrhagic area extending inwards and slightly to the left; the floor of the fourth ventricle showed extensive round celled infiltration. Medulla shows evidence of extensive meningeal inflamation. Examination of wet specimen of dura, several months later showed free

right lateral sinus to be only about ½ size of thrombosed left lateral sinus. Two lumbar punctures made about 16 days after operation on mastoid showed fluid clear under pressure, microscopical examination negative. Five weeks after operation, spontaneous very free discharge of clear cerebro spinal fluid from a small opening in inner wall of sinus.

Eagleton attributes all conditions following the operation including optic neuritis to have been due directly or indirectly to the sudden disturbances in the cranial circulation caused by the ligation of the jugular. He says, prior to ligation the absence of bleeding should have made us suspect that the thrombus was not completely occluding the sinus and thinks that this is of importance in assisting to diagnose an occluding thrombosis prior to the opening of the sinus.

Wootton (Report of Meeting of the Section on Ophthalmology of the New York Academy of Medicine, March 16, 1908. Archives of Ophthalmology, Vol. XXXVII, No. 4, p. 445) reports a case in which he found choked discs in a patient, over two weeks after simple mastoid operation. The sinus was opened accidentally by a spicula of bone. Complete recovery. Conditions which have led to their development seemed doubtful. Dr. W. was strongly in favor of cerebral abscess which had subsequently become encysted.

In the discussion following the report of this case Dr. C. Koller thought that the connection in this case was most probably a thrombosis of the sinus not necessarily septic. He had seen such cases. In one case he had accidentally torn the sinus and produced a non septic-thrombosis. This was followed by choked discs and hemorrhages. Some two weeks later the patient recovered. In two cases of infections non-occluding thrombosis, choked discs developed after ligation of the vein. All these cases cleared up perfectly and lasted from six to eight months.

Dr. T. R. Pooley said that in 1903 he had published a

report of a case of acute mastoiditis in which the sinus was exposed during the operation. Sinus thrombosis developed. The thrombosis was removed as far down as the jugular bulb. Pyaemic symptoms with abscesses and septic pneumonia followed. Within two weeks after the second operation choked discs developed. Patient recovered in about three months with no atrophy and good vision.

In view of the fact that it is quite common at present to attribute the appearance of an optic neuritis in complicated ear diseases to the presence of a serous meningo-encephalitis, it may not be uninteresting to reproduce here the findings of an autopsy made by the well-known ophthalmologist and bacteriologist, Dr. Morax of Paris.

Morax: Choked disc in intercranial complication of aural infections. (Bullet. Mem. de la Société française d'ophthalmologie, T. XXIV, 1903, p. 244, Abstract from the Ophthalmoscope June, 1903, p. 451.)

A case of chronic otorrhœa associated with thrombosis of lateral sinus, extradural abscess and double optic neuritis. Female child 10 years of age, day after admission right convergent strabismus (ext. rect. paresis). Lumbar puncture 30 cm. of cerebro spinal fluid was withdrawn, liquid escaped under strong pressure, was limpid, containing a few lymphocytes and was sterile as regards any growth of agar-agar or ascitesagar. Death 12 days after admission. No evidence of meningitis or of tubercles on the meningeal vessels. Thrombosis of left lateral sinus. An extradural abscess which stood in connection with the sinus. The cerebro-spinal fluid included no microbes capable of cultivation by the ordinary means and no organisms were found in smears prepared from it after centrifugilization. Inoculation of three guinea pigs with particles of the left optic nerve papilla and sheaths of the optic nerve yielded a negative result. In the sinus a clot was found in process of organization in addition to a microscopic mass.

In his opinion many of the symptoms of the intracranial manifestations of otitis infection are caused by the aug-

mentation in the amount of the cerebro spinal fluid, in other words, by internal hydrocephalus. This is shown during life by the pressure under which the fluid escapes when evacuated by lumbar puncture, as well as by the improvements in the cerebral symptoms and in sight, that often follow operations.

There are three hypotheses on which the high tension of the fluid has been explained: I. Toxic oedema connected with the presence of an infective focus. II. Oedema connected with circulatory disturbances. And III. Glandular hypersecretion.

Summing up the whole matter, he says: The oedematous neuritis (choked disc) which appears sometimes with or without impairment of vision in patients affected with chronic otorrhœa with intercranial complications is not the consequence of an extension of the infection to the meninges. It possesses the same pathogeny as the oedematous neuritis which accomplishes intracranial neoplasm or tubercles and like that is due to internal hydrocephalus. Its existence does not appear to modify the prognosis, the latter being materially influenced by opportune and complete intervention. He thinks that the optic neuritis which is occasionally seen in complicated cases of empyaema of the mastoid and also in otitis media may be due to an extension of the disease through the lymphatic vessels which accompany the external carotid artery.

Everbush, who has written the chapter on the diseases of the Eye in relation to diseases of the Ear, in Graefe-Saemisch, Handbuch d. Gesammten Augenheilkunde II Auflage, has this to say on this subject: It is probable that the optic neuritis and neuroretinitis which is developed in cases of suppuration of the ears and its consequences, is almost always, if not invariably, caused by the presence of phlogogenous, that is, toxic substances in the cerebro spinal fluid, a view expressed by Leber as long ago as 1881—with reference to the causes of affections of the optic nerve in connection with intracranial affections such as tumors.

etc. The swelling of the optic papilla and the congestion of the veins so frequently seen in these cases is the result, not the cause, of the inflammation of the optic nerve entrance. In confirmation of this view Elschnig has shown that an intraocular neuritis with or without oedema of the papilla occurs, but not a pure collateral oedema of the optic papilla and also of the optic nerve, as the sequence of intracranial tumor and inflammatory processes. The changes in the papilla are preceded by inflammatory changes in that part of the trunk of the nerve carrying the vessels, which gradually travels to the interlaminary part of the papilla. With this is noteworthy the localized appearance and the very conspicuous discontinuity as regards time, of the interstitial neuritis of the optic nerve trunk and also of the perineuritis as a local sign of intracranial inflammatory processes such as the constantly present chronic meningitis, both of which argue against the view that these diseases of the optic nerve are ascending or descending inflammations. An increase in the rapidity of the flow of the stream of cerebro spinal fluid from the brain to the eye in the intravginal space in consequence of intracranial pressure or an increase in the fluid itself—internal hydrocephalus—may heighten the possibility of the optic nerve disease. That an increased intracranial tension by itself cannot be the cause of the choked disc occurring in cases of ear disease, is proved chiefly by Knapp's observation that in spite of evacuation of the pus from the cranial cavity and escape of the very large quantity of cerebro spinal fluid, the optic neuritis increased from day to day in the following days.

Greef (Die Pathologische Anatomie des Auges, Berlin. 1902-1906, p. 733), is an opponent to this theory and says: Originally it is a pure stasis process caused by the increased intracranial pressure and is to be kept entirely apart from a neuritis. That inflammatory phenomena are soon added to the choked disc is true, and it is only in this connection that we see it at the anatomical examination. Experience and clinical observation confirms this. I mention only the

sudden appearance, the rising and falling, corresponding to the brain pressure which is often seen, and the absence of disturbance of function in the beginning. I have often seen and observed for a long time the choked disc with normal vision and a free visual field while in an inflammation of the papilla the function is disturbed from the beginning.

Brieger, Bericht, ueber die Verhandlungen d. deutschen Otologischen Gesellschaft, 1901, cited by Espenschied, thinks that the appearance of optic neuritis is evidently not incited by the venous stasis itself (in thrombosis of the lateral sinus), it seems more likely to depend on the pressure under which the brain-water stands, but more frequently still on a simultaneously existing inflammatory process in the arachnoidal space.

In my case the optic neuritis and the abducens paralysis may have been due to a toxic oedema in connection with the presence of an infective focus as well as to oedema connected with circulatory disturbances, as the circulation in the sinus was suddenly interrupted by the packing required to stop the hemorrhage from it, and the same may be said of almost all the cases quoted here, in which, as in my case, the sinus was accidentally injured.

The length of time required for the development of optic neuritis has been found in some cases to be as short as 24 hours, that is, in carefully observed cases the eye-grounds were normal on one day and on the following undoubted signs of optic neuritis were present; in other cases where daily examinations were made it has taken six and more days between the appearance of hyperaemia of the disc and a fully developed optic neuritis. But as in all cases of intraocular optic neuritis, an inflammatory condition of the optic nerve trunk probably precedes the appearance of the neuritis in the eye and this interstitial neuritis of the optic nerve may have existed many days before the intraocular optic neuritis became manifest. It is not improbable that in my case as well as others reported the intracranial condition giving rise to the inflammation of the optic nerve trunk was already present at the time of the operation.

The appearance of a bilateral optic neuritis with or without palsy of the abducens, immediately or soon after an operation for the elimination of an infected focus in the temporal bone or the sinus, brain membrane, or brain abscess should therefor not be regarded as a sign of the development of further complications nor as of prognostic importance. The complete recovery which has followed the post operative optic neuritis in many cases should teach us that the mere appearance of optic neuritis with or without paralysis of abducens nerve, but without other symptoms of intracranial disease, does not call for further surgical intervention.

Discussion.

Dr. Norval H. Pierce, Chicago:—I have had one case of septic thrombus of the sigmoid sinus with ligation and dissection of the jugular, followed by optic neuritis, choked disc, which in all probability did not exist before the operation. The eyes had not been examined except a week or ten days before, and at that time were found to be healthy. The optic neuritis existed for four months afterwards and was present at the last time his eyes were examined. He never complained of disturbance of vision; in fact, three weeks after the operation he went about his business, that of druggist. During the time he was under observation he complained of headache. He was a melancholic man, a Russian, who became so morose that his relatives feared he would commit suicide. However, the changes in the retinal vessels improved after about two months and the ophthalmologist said that almost coincidentally with this improvement his whole mental character changed and the headaches disappeared. He went from under my observation, although I am still in communication with him and he is in good health and complains of no headaches.

Dr. E. A. Crockett, Boston:—I reported to this Society in 1905 three or four cases where an optic neuritis came on

after ligation of the internal jugular and I think Dr. Gruening reported some cases last year of the same kind. It has always seemed to me that it is an extremely common symptom following ligation of the internal jugular. Without being accurate in my statistics I should say it has been observed in the last five years at the Eye and Ear Infirmary in 30 or 40% of the cases. I never happen to have seen a case with paralysis of the eye muscles.

Dr. G. A. Leland, Boston—It seems to me that jugular ligation in this case gave rise to more localized symptoms than it does in most cases which are apt to be more like those mentioned by Dr. Crockett, where there was only a mild but distinct venous stasis.

I had a case some years ago, which I have intended to report, where after ligation of the internal jugular and evacuation of the epidural abscess,—not in the usual position around the perisinous space, but under the cerebellum, so that the probe went in almost to the foramen magnum,—there was choked disc following, and dimness of vision was complained of in the right eye only.

Then we had paralysis of the sixth and marked exophthalmous which was progressive. There was first internal strabismus on the right side and some paralysis of the motor oculi. Then it went over to the other side which showed about a third to a half as much involvment as the right. Hence we concluded we had an extension up through the communicating veins to the cavernous sinus and slight thrombosis of that sinus, beginning on, and more marked on the right but extending to the left. It gradually disappeared, however, without operation. The case was one that came into the City Hospital for the chills of malaria; and the marked right retropharyngeal swelling was supposed by a surgeon and a laryngologist to indicate a deep abscess in the neck. This was the cellular swelling caused by the venous stasis. The patient went on to complete recovery.

Dr. Harry Friedenwald, Baltimore:—Dr. Kipp has mentioned a case which I recently gave in rather brief detail at another meeting and which I should like to include in this discussion. It is interesting in this respect that it was one of the least complicated of all that Dr. Kipp has mentioned.

Mary P., aged 32, a large Negress, applied at Baltimore Eye, Ear and Throat Charity Hospital on Feb. 20, 1906, for the relief of acute suppurative otitis media, of the left ear, of two weeks duration. After lasting one week the discharge had set in. She had had pain during this entire period; it had been extremely painful behind the ear during the preceding 3 or 4 days. At the time of her first visit her temperature was 99.4, the meatus was filled with pus, the drum was very red and bulging; there was considerable sinking of the posterior superior wall and marked swelling behind the auricle. A paracentesis was done immediately. She was urged to remain for hospital treatment, but did not enter the hospital until March 1st. At this time temperature was normal. She complained of great pain at night; the oedema over mastoid had disappeared.

Operation: She was operated upon by Dr. Sylvan Rosenheim and myself on March 3rd in the usual manner. The mastoid cells were full of pus under pressure; the bone was soft, easily curretted away. The lateral sinus was exposed over a distance of almost half an inch, and in the upper part it was covered by granulation tissue. The antrum contained much granulation tissue which was removed, and free connection was made between it and mastoid cells.

The mastoid tip was then opened and pus gushed out under considerable pressure. The tip of the mastoid was one large cell with much granulation tissue which was curretted away. Then it was found on probing that the posterior bony wall had been destroyed, again exposing the lateral sinus. The softened bony substance between the upper and lower mastoid wounds was next removed. The entire cavity was then irrigated, all the rough edges having been rounded off.

Preparatory to packing, the cavity was mopped out with dry gauze, which was packed in and then withdrawn. On withdrawing the packing from the cavity in the tip, a profuse venous hemorrhage occurred, evidently coming from the lateral sinus. The cavity was packed with iodoform gauze which controlled the hemorrhage, and the usual dressings applied.

The patient rapidly recovered consciousness; vomited frequently. Her temperature during the rest of the day and on the following day was about 99, but her pulse fell from between 80 and 88 before the operation to 68 on the evening of the second day. On the third day after the operation her temperature rose to 101, the pulse remaining 68 or lower. She complained of a chilly sensation. On the fourth day her temperature and pulse continued as before, but on the fifth there was a rapid rise to 102.5 at 1 p. m., 103.6 at 3.30 p. m., remaining so until 7 p. m., dropping at 9.30 to 102.4: at 12 a. m. to 101, and continuing to decline, without any further rises during the subsequent history. Without the exception of the very few hours of high temperature when the pulse rose to 100, it remained low for several days. (See temperature and pulse chart.)

The first dressing was made when the temperature rose, but nothing was found to account for it. During this period the patient did not complain much, except of a roaring sound in the ear. On the eighth day she was exceedingly drowsy and it required great effort to awaken her.

On March 8th, the fifth day after operation and the day following the high temperature, the patient was examined with the ophthalmoscope and showed optic neuritis in both eyes. There was also deplopia due to paresis of the left external rectus. The optic neuritis increased markedly from day to day and became a typical choked disc. After the sixth day her temperature became normal and remained so. The pulse became normal about the tenth day. The patient made an uneventful recovery.

Her vision was tested on March 19th, and found to be

right, 16-20 partly, left 16-40, with a high degree of choked disc. She was discharged from the hospital March 29th with vision of the right eye 16-40, left eye 16-70, and subsequently treated in the outdoor department. The wound healed nicely.

On October 11, 1906 (seven months after the operation) her condition was as follows: Feels well. Sight, which had been very bad, has now improved. Occasionally complains of ache over eyes and of pains in different parts of head. Wound behind ear has healed, leaving only slight depression. The left drumhead has healed with slight redness and thickening of upper portion of the handle of the hammer. Hearing, left ear, watch 2 inches, whisper 12 feet. Rinne positive.

Ophthalmoscope examination. Right eye, very little swelling, between 1 and 2 D. Veins not tortuous and not very full. Arteries somewhat narrow, disc red, margin obscured.

Left eye shows the same condition, but more marked. Vision, right eye 16-30, left eye 16-100. There is no evidence of muscular impairment.

In reference to what Dr. Crockett has said as to the frequency of choked disc, I have examined the fundus in every case of lateral sinus disease that I have seen, certainly a dozen or more, and I have never seen a choked disc in any of them. I should like to ask if he meant that there was a mild form of optic neuritis in some of these cases, because in the history of the cases I find in the literature no such proportion of choked disc has ever been reported as 30 or 40%. I have never seen it except in this one case.

Dr. Crockett:—Have you examined your cases after ligation?

Dr. Friedenwald:—Yes.

Dr. Crockett:—I should say that I am not sure of my figures, but in a large percentage of cases we found more

than a papillitis. I am not an ophthalmologist and do not know the exact stages, but it was more than a papillitis and in a good many cases a well marked choked disc with retinal hemorrhages.

Dr. Emil Gruening, New York: The choked disc which we find in connection with ear disease is different from any optic neuritis that the ophthalmologist has occasion to observe. Generally he fears a neuritis and doesn't know what the outcome will be. In the majority of cases a choked disc will cause some disturbance in the function of vision. Now a choked disc that we see in connection with ear disease, especially in connection with sinus thrombosis, never causes any harm to vision; it always disappears provided the case gets well. So I think in a number of cases which I have seen and from the literature the neuritis of sinus thrombosis is not to be feared. But that the neuritis is not due to the thrombosis is evident. I do not see why a choked disc should come on after ligation. I do not think the ligation has anything to do with it, because the sinus is thrombosed and closed above before we ligate and there is as much collateral circulation after as before.

I have now a case I wish to report to this Society where after a thrombosis of the lateral sinus and ligation of the left internal jugular, the two cavernous sinuses and a number of other sinuses were thrombosed, and in this case from beginning to end there was no choked disc, although almost every intracranial sinus was blocked and some of the thrombosed veins could be followed into the orbit.

Dr. B. Alex. Randall, Philadelphia:—Like Dr. Friedenwald I have studied very closely the eye-changes in these cases of intracranial complication and have been struck by the small amount of optic involvement which I have seen. A good many show a little fullness of the vessels, possibly a little oedema of the retina that doesn't elevate the disc into a papillitis, but anything beyond that has been very rarely seen, in spite of some pretty serious conditions.

I reported some years ago a case that has some relation to that of the paper, although I can give but a very imperfect account of it. A child that gave little evidence of sight was sent to me for examination of the eyes and my examination showed white atrophic nerves. Seeking the explanation of this, apparently a postneuritic atrophy, I found the left ear suppurating with a history of its having been so for most of the child's life; and as the physician said about it, "Doctor, that child had brain fever and it was the funniest I ever saw; it was all on one side, except both eyes bulged out." It was not difficult to read between the lines that there had been here a phlebitis at least and probable thrombus of the lateral sinus, involving probably the cavernous sinus of the opposite side. The nerves had suffered a papillitis and subsequent atrophy and it looked as though the child's eye-sight was gone; but that child has recovered a great deal of sight and is going about in a normal way.

I have seen a group of cases with paralysis, especially of the externus, and have had the good luck to see several of them come through safely. One was rather curious and I hesitate to tell it on myself. The child had scarlatinatotitis and mastoiditis; I cleaned out, laying the sinus bare and also the dura over the tegmen because of the carious condition I found there. The operation was about as thorough and complete a cleaning out of an acute mastoid as I have ever done or seen done. The child made an interrupted but good recovery: no symptoms of trouble appeared for five years. Then in an attack of grippe the ears flared up and there was mastoiditis on the other side which cleared up; but on this side I had to operate again. The mastoid was of normal form and you would not have believed it to have been operated on previously if you had seen it, although I knew that I could have put both my thumbs in the operation cavity. I practically could not find the bony scar of the first operation. In the exhibit next door I have a specimen of a temporal from a tuberculous child where there is in one year almost complete closure of the bony wound, but still a scar; this child had none.

Dr. Hiram Woods, Baltimore:—I want to put on record the following case, apropos of Dr. Kipp's paper:

A girl, 14 years old, was admitted to the University of Maryland Hospital in Baltimore with a fluctuating swelling one inch below the mastoid tip. History of chronic suppurative otitis media. On operation I expected to find a Betzold abscess but was unable to discover the opening in the tip if it existed. The eyes were examined before operation and found normal; vision 20-15 in each eye. She did well for a few days when she developed a slow pulse, subnormal temperature, and examination of the eyes showed an optic neuritis, or choked disc, amounting to about 3 D.

An opening was made over the tympanic roof, 1¼ inches above the meatus. No subdural abscess found, but the dura was tense and bulged into the wound. Pulsation was not felt. The dura was incised giving exit to an accumulation of serous fluid which came out under considerable pressure. Within a week the optic neuritis showed evidence of clearing and the girl made a good recovery.

I attributed the optic neuritis to pressure produced by a serous meningitis occurring in the neighborhood of the suppurating cavity.

Dr. C. J. Kipp, Newark, (closing discussion): I reported this case simply because I think there are but few on record where examinations of the eye were made after operation. It has been my practice for twenty-five years to examine every case of otitis media ophtahlmoscopically. In this case there were no eye ground changes before operation. The papilla measured 3 D the day I saw it, seventeen days after operation. The neuritis may have been going on a week or more before I saw it.

I think very few people examine the eye ground after operation. There is no necessity, of course, unless the patient complains of loss of sight or squint, which is rare. Of course, if they have paralysis of the ocular muscles you will have your attention called to it. In this case there was

abducens paralysis as well as the optic neuritis, both due, doubtless, to the same cause.

In regard to what Dr. Gruening has said about the loss of sight from optic neuritis associated with thrombosis of the lateral sinus, I don't think his experience is that of others altogether. In one case I know of, complete blindness developed a few days after the optic neuritis. There are several cases on record where blindness has resulted. But as a rule impairment or loss of vision does not follow this form of optic neuritis.

REPORT OF CASE OF VERTIGO.

By DR. E. A. CROCKETT, Boston, Mass.

This paper is to be considered as a continuation of one entitled "The Removal of the Stapes for the Relief of Auditory Vertigo." (The Annals of Otology, Rhinology, and Laryngology, March, 1903), and is written largely for the purpose of calling attention to the value of this procedure in selected cases in despite of the prevailing lack of enthusiasm for stapes operations.

Cases of auditory vertigo of the type of which this individual is an example are rare, but when seen they are the most troublesome of any which the aurist meets.

G. T., 35 years old, was first seen February 2, 1907. He was a perfectly strong healthy man, rather neurotic and a good deal overworked, but without any localized manifestations to account for his symptoms.

Two or three years before beginning treatment, he had noticed ringing in both ears and for the last year he had not been able to hear well and the deafness had steadily increased. Both drum membranes were very thick but without cicatrix or calcification, there was also marked hypertrophic rhinitis. His hearing in the right ear was normal although the drum was thickened. In the left ear he heard a loud ticking watch at two inches, low spoken voice was not heard at all, loud spoken voice at six inches, probably by bone conduction. His lower tone limit was 512 v. s.—the high tone limit was normal.

Between two or three years before his first visit he had sudden attacks of vertigo, nausea and vomiting lasting about half a day. For some months prior to these attacks he had had a constant feeling of pressure and lightness in his head.

Subsequently he had attacks of vertigo once or twice a month from 1905 to 1907. These attacks were always precipitated by sudden change of position, as for instance, bending forward suddenly to lace his boots or throwing himself back in bed. During the whole of these two years he had no treatment for his ears at all, but had been to a specialist on internal medicine, who had treated him for chronic gastritis. He had been on a rigid diet for over a year without any improvement in his vertigo, in fact his condition grew worse. The general character of his vertigo was always the same. On the day of the attack he would have a confused sensation in his head, often for two or three days prior to the onset, then as I have said before, from any sudden change of position an attack would at once begin with violent vertigo of the type where the ground would seem to come up and strike him and he would fall forward if he were unable to go to a chair or be held by some one. He would then in two or three minutes begin vomiting violently and this would last two or three hours, when the attack would pass off leaving him perfectly well for two or three weeks. The attacks seemed to bear no relation to what he ate and there was no loss of consciousness in any of them.

In March, 1907, the character of his attacks changed to a practically continuous vertigo. He was seldom free from a certain amount of equilibrium disturbance during the day and he often staggered when he walked and he was afraid of being arrested for drunkenness. There was a continual sensation of fullness in his head and a good deal of mental depression. The attacks of nausea and vomiting at the last, just before I operated upon him, often occurred once, twice or three times a day.

An examination by a neurologist revealed no disturbance of the nervous system, the reflexes were normal and there was no nystagmus. No amount of argument could persuade the patient that he was a subject of a curable disease. He began to be melancholic and was entirely unfit to carry on his business.

An examination of his eyes by an oculist showed no muscle trouble or refractive error beyond a slight myopia of which had been corrected by glasses. Thinking that overwork and business worry might be a factor in this case, I advised a vacation, but after being away about ten days, during which time the patient had daily attacks of vertigo, he came home saying that he did not care for any further vacation under such circumstances.

After about two months treatment with the Eustachian catheter and Politzer bag and cauterizing his nose, stopping his smoking and administrating iodide of potassium in small doses, I advised him to have the stapes of the deaf ear removed, not promising him definitely that relief would be obtained, largely because I was afraid, owing to the extreme amount of ossicular fixation shown by the hearing test, that I would be unable to remove the stapes without fracturing the crura. Notwithstanding, in June, 1907, he was etherized and the usual flap incision was made over the incudo stapedial joint. This was severed with a right angle knife and the incus removed. The stapes was clearly seen to be freely movable and was easily extracted with a right angle hook. Much to my surprise, the interference with the low tone vibration in this case must have been other than in the base plate of the stapes. There was a good deal of disturbance of equilibration and some nausea for two days following this operation. The flap in the membrane tympani healed very promptly and the patient left the hospital in three days and began his business in a week. He had slight equilibrium disturbances for the next month, but not enough to interfere with his business, to which he went every day. The long continued severe vertigo in this case made the patient very nervous. He still complains of slight vertigo at the present time, (more than a year since the operation). He finds it hard to describe exactly these attacks, but they are evidently only transitory and never noticeable to anyone but himself. They have never lasted more than two or three minutes, at any time in the last six months and have been entirely un-

accompanied by nausea or vomiting. The hearing in the operated ear is practically gone, but, of course, it was far from good prior to the operation.

Exactly what the mechanism is which produces the severe vertigo in this case must of course be only a matter of surmise. I have always thought that any interference with the free motion of the base plate of the stapes and of the membrana of the round window must produce an increased labyrinthine pressure in combination with any external cause which throws more blood into the internal ear. This would otherwise be compensated for by the outward motion of the stapes or round window and it seems to me that it must be this portion of the auditory mechanism which is usually at fault, but, in this case and in one other, the stapes was found to be freely movable, so movable that it could be distinctly seen to change position on touching it with a probe.

In this particular case, the operation can certainly be counted as successful although the patient's vertigo has not entirely ceased. In the other case in which the stapes was found to be movable at the time of operation, the vertigo had persisted for over a year prior to the operation and rendered the patient unable to work for more than half that time. It ceased entirely in this case also after the movable stapes was removed. Undoubtedly in all these cases the patient gets very melancholic over the continuance of the vertigo and it may be open to question how far the psychic element plays a part in the improvement resulting from the operation, but that this factor is of very little importance is clearly shown in two cases of typical auditory vertigo of long duration, in both of whom the stapes broke on the attempt at removal owing to the firm fixation of the base plate and oval window. Both of these cases have received no improvement whatever from the operation, not even the temporary effect which might be expected would be received from any operative procedure and in both of these cases the vertigo continues in frequent severe attacks up to the present time. One of these was operated in 1899 and the other in 1902, both are inter-

esting as showing the long continuance of the attacks. Both have had severe attacks of nausea, vomiting and vertigo lasting from one half an hour to a day, once in two or three weeks. for eight or nine years. All forms of medical treatment have been tried and various doctors have been consulted. but no improvement has been received by any method of treatment followed in either case.

I firmly believe that the failure to remove the base plate was responsible for the continued vertigo in these two patients. Had I the courage of my convictions. I should certainly recommend a destructive operation on the labyrinth in each case but I hardly feel justified in recomemnding so severe a surgical operative procedure to a patient who is not suffering from a serious ear disease. I do not recommend the operation of stapedectomy except as an operation of last resort. but think that the number of cases of this type of vertigo is very large and they are not recognized by the aurist in many instances, because the patients themselves have no idea that the vertigo has any connection with the ear, hence they do not give any information on the subject to the physician unless by direct questioning. I am firmly convinced that many are treated by general practitioners for chronic gastritis. as in this case I have detailed today, or for neuresthenia or under the supposition that they have chronic interstitial nephritis or cardiac disease. On the other hand. the aurist must be extremely careful to differentiate any general disease as the cause and only to call auditory vertigo those cases which present no demonstrable general lesion. We must remember that in anteriosclerosis. cardiac or renal disease and in the beginning stages of many diseases of the nervous system, especially cerebellar tumors or abscess and locomoter ataxia, veritgo may be not only a very prominent symptom, but a very early symptom and the greatest of care will have to be exercised in separating these from true cases of auditory vertigo. It has not been my experience that chronic digestive disturbances are very frequently the cause of severe vertigo. nor contrary to the

usual opinion have I found that eye trouble, especially refractive errors, are at all common as a causative factor in this class of cases. Hypermytropia may cause a slight general disturbance of equilibrium.

As I said in the former article, many types of auditory vertigo may be relieved by simpler operations as, for instance, the removal of the incus as advocated for so many years by Dr. Burnett. No doubt improvement in the amount of vertigo was obtained by removal of the incus without any interference with the stapes, but our knowledge of pathology of the middle ear disease goes to show that the lesions of the malleo incudal or incudo stapedial joints are rare, as a cause of deafness or of fixation of the ossicular chain. The common lesion is about the base plate of the stapes in the form of periostitis or ostitis and in this class of cases nothing short of removal of the base plate is going to be of no avail, conversely it will be found impossible to remove the base plate in advanced otosclerosis owing to the firm union between the bone and the oval window. How far advanced this process is must be judged partly by the history of the case and partly by the hearing test. Where in such cases a low tone deafness does not rise above middle C and where there is no high-tone deafness, the operation of stapedectomy may be undertaken with a fair chance of success. Where the high tone limit is below 20,000 vibration or the lower limit of hearing is above 512 vibrations, the chances of the removal of the ossicle entire is very slight.

Fortunately the greater portion of the cases that the writer has operated upon for vertigo have been in instances for a general thickening process about the middle ear, either the result of so called chronic middle ear catarrh or some former suppurative middle ear lesion and such cases offer a far better chance of success than the cases of otosclerosis. In all the cases where the stapes has been removed, a decided improvement has resulted. So decided as to be called an absolute cure.

Discussion.

Dr. F. L. Jack, Boston:—The subject of stapedectomy has been a most interesting one to me for the past ten or twelve years. Whereas I have practically put the operation in use less and less frequently as time has gone by, I have made up my mind that the class of cases which Dr. Crockett has spoken of is the one in which the operation is justifiable. The fact that the stapes can be removed surgically without any fatal result was demonstrated in 1891. The experiment was tried on some fifteen or eighteen patients, the idea having been suggested by Botey a year before in his experiments on animals.

Personally I have operated on four cases of aural vertigo; with very satisfactory results in two; less satisfactory in two others. I do not wish to weary you by stating individual cases, but it seems to me that every one of them is interesting and so perhaps you will pardon me if I speak of one or two briefly.

The first case in which I operated for the relief of vertigo was a year or two after having experimented to improve the hearing and in this case the crura broke, as they often will, leaving the foot plate. As this was a marked case of vertigo and the crura had broken, indicating that the basal membrane was the cause of the trouble, I determined to let out some of the labyrinthine fluid and see what that would do. With a small steel probe I succeeded in penetrating the base plate and as soon as an opening was made a gush of a few drops of clear fluid followed. This patient had great relief from the vertigo for some time, but the trouble came back again. I suppose perhaps the hole covered over.

Another case was that of a cab-man, who found that once or twice a day he was toppling off his cab. He prayed that something might be done for his relief as otherwise he would not be able to make his living. It was determined that he had aural vertigo. It was stated to him, that he might get relief and that it might destroy what hearing he had. He

was ready to consent to anything. The operation was performed; it was very simple, the stapes coming away in toto. He had no dizziness after the operation. We kept him under observation in the hospital ten days. He went to work shortly after and for some months, until lost sight of, he was all right.

A third case was a radical, in which the head of the stapes was exposed so that in wiping the ear out touching it would almost throw the patient off the chair. The case was one from a distance and I was anxious to cover in the wound with flaps, but did not know what to do with the stapes. He was put under ether preparatory to having the flaps put in and the operator broke off the head of the stapes in the attempt to remove it. He covered the fenestra ovalis with the flap and there was no more dizziness afterwards.

Now to my mind there is no doubt, as Dr. Crockett has emphasized in his paper, that in a suitable case of aural vertigo there is a very good chance of helping the patient if not of stopping the dizziness entirely by removing the stapes and relieving the pressure.

Dr. George E. Shambaugh, Chicago:—This is a most interesting subject, and there are a number of points in the paper that might call forth considerable discussion. In the first place as to whether the deafness had anything to do with the middle ear trouble; both membranes appeared to be altered, but we frequently find this unassociated with any deafness at all. In one ear I understand there was no defect in the hearing at all. The question is whether the deafness on the other side was due to the middle ear catarrh. The fact that the stapes was found free indicates that the deafness had nothing to do with the conducting mechanism, and that it was probably of a labyrinthine type. Of course, in a general way, when we find a marked defect for lower tones we consider it a case of middle ear obstruction, and when we find the defect for the upper part of the scale we consider it one of the labyrinthine type. I have examined several cases

where the defect was limited to the lower part of the scale, and yet there was no question but that it was of the labyrinthine type. There is no reason, of course, why that part of the organ of Corti which takes up the lower tones might not be involved in the same way as the part which takes up the higher tones. In Dr. Crockett's case I should be inclined to think the trouble was at the apex of the cochlea rather than at the base.

Now what causes the vertigo anyway? It must be some disturbance of the ampullae; some disturbance of the fluid in the membranous labyrinth. How it is that a continued pressure can cause vertigo is not clear. If you increase the pressure and keep it increased I do not see how you can cause a flowing of the fluid, and unless you have this you do not get the stimulation of the hair cells in the crista ampullaris. It has been brought out in the work of Barany that cold water injected into the ear will produce vertigo in one direction, and hot water in the opposite direction. If you have the stapes bound down the pressure would be constant, and I do not see how prolonged disturbances of equilibrium could result. Unquestionably there have been results obtained in the relief of the vertigo by removal of the foot plate of the stapes in these cases, but I think it due to the fact that the fluids of the labyrinth escape and the function of the labyrinth is destroyed. The function of hearing will also be destroyed in such cases just as the function of the semicircular canals is destroyed, and of course that would make us hesitate about resorting to this procedure in order to relieve the vertigo. The fact, as Dr. Jack has pointed out, that one of the cases was relieved by puncturing through the foot plate, was followed later by recurrence of symptoms, points to the probability that a scar had formed over the opening and the perilymph was renewed, and the possibility of disturbance of the fluid was re-established. This naturally leads up to the question of whether one might not be justified in very severe cases of vertigo or tinnitus aurium in perforating the promontory and injecting a fluid into the

labyrinth which would destroy the end organs in this structure. Such an operation would not be difficult, and the possibility of producing an infection in the labyrinth which might lead to meningitis is perhaps the most serious objection.

Dr. Sargent F. Snow, Syracuse, N. Y.:—I can report two cases decidedly of the nature of Dr. Crockett's which had such pronounced symptoms and which responded to another method of treatment that I think it worth while to speak of them.

The first, a druggist about 50 years of age who had for six months been so severely troubled with aural vertigo that he had to have an attendant constantly with him. Once or twice when he came to see me he had been carried into stores and laid up for an hour or so. This patient presented constitutional symptoms that I thought accounted for his trouble. His tongue was badly furred and there was every evidence of torpid liver. The nasal tissues were engorged and I removed the anterior third of the middle turbinates and while under observation his diet was corrected and he was given a mercurial twice a week. This treatment resulted in a cure that has remained permanent for three years.

Another case I have just finished treating was unable to work; his wife had to go with him on the street; he would fall out of the chair in the office. I found that he had marked Eustachian catarrh, badly furred tongue, and evidence of torpid liver. I did not advise intranasal operation in his case but treated his digestive disturbance and the Eustachian membrane locally with camphor-iodine vapor. He made a complete recovery in six weeks and has been well now for about six weeks. I mentioned these cases because I think that in the preliminary stages of the trouble that Dr. Crockett has referred to, much can often be done in this way. Of course his cases were decidedly chronic and undoubtedly required the operative measures he resorted to.

Dr. Arthur B. Duel, New York:—It seems to me that a

careful consideration of the results would lead us to take the view of Dr. Shambaugh, viz: that the relief is due to destruction of the function of the labyrinth rather than to relief of pressure, because in other instances where the stapes is removed the subsequent repair must be by scar tissue which is immovable as compared with the stapes.

Dr. H. O. Reik, Baltimore:—I would ask the essayist in closing to give us some advice as to the indications for the operation of stapedectomy in aural vertigo. Both Dr. Crockett and Dr. Jack have emphasized the importance of performing the operation only on selected cases; can they from their experience determine which cases will do well with incudectomy and which should be submitted to stapedectomy.

Dr. Norval H. Pierce, Chicago:—I would like to ask Dr. Crockett whether in his examinations he used the Rinne test?

Dr. Crockett:—Rinne was positive and bone conduction prolonged.

Dr. Pierce:—That is rather nonplusing, because we have believed that these factors are almost pathognomonic of stapes fixation. That would be against Dr. Shambaugh's theory that it was a change in the labyrinth or in the nerve endings. Such cases cannot be understood with our present knowledge. That relief may be given from vertigo and dizziness by change in the labyrinthine pressure there can be no doubt. I have had two cases, one with marked deafness, and the other with extreme tinnitus, in which the relief was most marked by lumbar puncture. It was not permanent, but within six months the symptoms recurred. Their health had greatly improved in the meantime and perhaps the nervous element had been minimized. It would be extremely encouraging if we could possibly arrive at a dif-

ferentiation of these cases. If we could know with a reasonable degree of certainty that we could expect amelioration of the vertigo or tinnitus in staped ankylosis, because I believe that is the condition which we have to deal with, whether with stapedectomy we could expect a betterment of the condition, it would be very encouraging. I think our efforts should be directed more to the matter of differentiation in these cases.

I would like some explanation from Dr. Crockett as to how he accounts for this prolonged bone conduction and positive Rinne, with loss of lower tone limit, without stapes fixation.

Dr. Shambaugh:—I think there must be some mistake as to the functional examination Dr. Crockett speaks of. He says the Rinne was positive; that could not be if one side was deaf and the other normal.

Dr. Crockett (closing discussion):—The Rinne test, as nearly as I can remember, was 10 seconds by air and 15 seconds by bone conduction; bone conduction was prolonged. I am not able to account for this myself. I remember several cases with Dr. Jack, in the first series he published, in which we found a movable stapes with tests that indicated fixation.

I do think, however, that the relief this patient obtained came from destruction of the function of the labyrinth. I am quite sure that in all the successful cases I have had the hearing following the operation has been practically nil. If you go into the case histories of extreme aural vertigo, you find that the vertigo persists until hearing is by natural processes obliterated. We simply anticipate in these cases that process.

Dr. Snow's cases were not such as would require operation, nor would I advocate operation in such cases. These cases had preliminary treatment for nearly three years. I would not operate on a case within six months of the time I first saw it, nor without having the patient consult a neurologist, oculist and general practitioner. But, given one of these

cases of extreme vertigo, where you can not find any other process to account for it except the auditory process, the patient will agree to anything when they see no prospect of relief in any other way. I have never told a patient I could promise any result and have always told them it would obliterate hearing in the affected ear, but they are incapacitated for business and become melancholy and are glad to accept any hope of relief.

As to the selection of cases, I think it is difficult to lay down any general rule. I would simply do it in every case as a last resort. I have had quite a number of cases of simple removal of the incus. One of the cases reported in the St. Louis Archives was with a preliminary removal of the incus without any relief to the patient whatever. Finally, I removed the stapes and there was considerable relief at once and complete relief in two months. Personally I do not operate to remove the incus except to clear the road for removal of the stapes.

One thing I noticed at the meeting in Pittsburg that did not agree with my experience was that Dr. Jansen and some of the members of the Association in speaking of the labyrinthine affections in the course of mastoiditis said that it was a serious thing to remove the stapes in the course of a suppuration of the middle ear. Several of Dr. Jack's cases and two or three of mine were where it was removed in the course of chronic suppuration, and in none was there any serious involvement of the labyrinth or meningitis from extension. In many of the cases done as long as fifteen years ago, probably due to lack of extreme surgical cleanliness, suppurative process would follow thirty-six hours later. There, of course, the stapes was removed and the labyrinth open to the suppurative process, but we must have seen twenty or thirty of these cases, and we never saw the labyrinth involved.

Dr. Emil Gruening, New York: The discussion shows that there is some difficulty on the part of some of the members

to remember what Rinne positive and negative mean. I experienced this difficulty when I first read of the test and finally had recourse to mnemonies. I said this is like a night-mare to me, which in German is "alp," and I adopted that word to recall the matter to my mind, and since that I have never had any trouble with it.

A—aërial.

L—longer.

P—positive.

A BRIEF HISTORICAL AND CRITICAL REVIEW OF OPERATIONS FOR THE CURE OF CHRONIC EAR SUPPURATION.

By NORVAL H. PIERCE, M. D., Chicago.

The object of this paper is not to go into the details of the historic development of operations for the cure of chronic ear suppuration, nor to deal with the slight modifications that have arisen, but rather to deal with the subject on broad lines and to consider the chief milestones that have marked the development in technic. I shall pass over the scattered instances where the mastoid has been opened unassisted by intelligent surgical or pathological data, sufficing to say that the Frenchman, J. L. Pettit, who died in 1750, was probably the first of whom we have any record to penetrate the mastoid for the cure of caries rather than the Prussian Army Surgeon Jasser, to whom this honor was for a long time ascribed, and to pay our passing respects to Baron Dr. von Bergher, who died a martyr to his own operative unskilfulness in this direction for the cure of unbearable tinnitus and a high degree of deafness. A few years before Schwartze's epoch-making contribution (1873) "Ueber die Künstliche Eröffnung des Warzenfortsatzes" the American Otological Society was founded, and American otology took on a vitality which has increased to the present day. In his "Report on the Progress of Otology" read before this Society July 19th, 1871, Albert H. Buck says: "Hitherto (that is since the death of Toynbee) the Germans have almost monopolized the field. The past year has been characterized by increased interest taken by both Americans and English in all matters pertaining to the ear." The papers of St. John Roosa, read at the Third Annual Meeting of this Society in 1870, that of J. Orne

Green read at the fourth, and that of Charles J. Kipp read at the sixth annual meeting of this Society conclusively show that the gravity of suppuration within the mastoid together with the necessity for surgical drainage was fully appreciated. As this paper must be limited to the consideration of operations for **chronic** suppuration this phase of the subject cannot be dealt with as fully as one might wish, and I shall bring it to a close by calling attention to two curious literary facts. In the Report on the Progress of Otology for 1874 read at the seventh meeting of this Society no mention is made of Schwartze's contribution. The other fact is that in Schwartze's contribution no mention is made of the work of St. John Roosa, J. Orne Green, Charles J. Kipp or C. R. Agnew. However, to Schwartze belongs the honor of first placing the operative technique for draining the mastoid antrum on a firm foundation. Not only was the subject before his time unsettled in Germany, but there was a strong feeling among many surgeons and otologists against the reasonableness of opening the mastoid for any cause. In spite of this opposition, Schwartze, from the studies of von Tröltsch and himself on the anatomy and pathology of suppurative ear disease, and after operations on the cadaver, concluded that the antrum could be drained exteriorly with safety and benefit to the sufferers from suppurative ear disease. In 1873 he published his first cases, and from that time to 1890 otologists operated according to his method. He did not differentiate between chronic and acute cases, but subjected both classes to the same operation. The operation, briefly considered, consists in making an incision reaching from the tip of the mastoid to a point on a line with the superior wall of the external auditory canal, elevation of the periosteum, and penetration of the bone to the antrum. One of the greatest advancements in clinical surgery Schwartze offered was the discarding of trephines and drills—substituting the chisel and mallet for this purpose. The external wound was kept open, a drain introduced into the antrum, and irrigation carried on through the

external auditory canal, Eustachian tube, and posterior opening. In order to prevent granulation tissue from accumulating about the external drain in those cases of prolonged after treatment, he substituted various appliances, and, at least, the lead nail, which was retained in the posterior fistula by means of an apparatus held in place by a steel band going over the head.

The acute cases did comparatively well, but the chronic cases either died of complicating cerebral disease or dragged through a long after treatment, sometimes extending over years.

In 1889 Küster and von Bergmann published their papers which marked a turning point in the operative technic of this branch of surgery. The paper of E. Küster was entitled "Uber die Grundsätze der Behandlung von Eiterungen in Starrwandigen Hőlen, etc. Deutsche Med. Wochenscrift, No. 13, 1889, p. 2541."

His object in this paper was to establish a principle in the treatment of cavities with non-collapsible walls; that is: the antrum of Highmore, the pleural cavity and antrum mastoidium. This principle consisted in the thorough and complete removal of diseased tissue through sufficiently large openings and the establishment of drainage and counter drainage, for the purpose of shortening after treatment.

As regards ear suppuration, he divides the cases into two groups: First, those cases in which the process was primarily in the mastoid and in which the cavum was little or not at all affected. Second, those cases in which the middle ear (cavum) was primarily affected with or without secondary participation of the bone. In the first group he places the cases of cholesteatoma, tuberculosis, and acute infectious myelitis. In the second he places the cases of primary suppuration within the cavum. His technic may be divided under three heads: He operated on the first group of cases in the following manner: After the usual incision, he uses a broad chisel, preferring this to the gouge, with which he cuts out a piece of the corticalis about two centimeters

broad on a level with the external auditory canal. If softened bone lies beneath, he scrapes this out until he comes to healthy bone. If the corticalis is undermined, he removes the overhanging borders. . . . If the bone under the corticalis is hard, he penetrates the bone (an irgend einer Stelle) by very light strokes, breaking the underlying bone off by a prying motion of the chisel. . . . If the case is one of primary affection of the mastoid, without severe involvement of the middle ear, the operation is here ended. He concludes this portion of the essay thus: "die Mittleohr eiterung erlischt mit Sicherheit so bald jader Rest des Krankheitsherdes entfernt ist."

The second group of cases were operated on as above, except that the posterior wall of the external auditory canal was taken away. If a part of the tympanic membrane and ossicles still remain, the external canal is enlarged as far as possible laterally from the tympanic membrane, and a drain inserted, one end of which issued through the external auditory canal (aussern ohr) and the other through the wound. If the cavum is filled with granulations, and the tympanic membrane and ossicles are entirely, or for the most part, lost, the contents of the cavum are removed. A drain is inserted as in the former class of cases, or the depths of the wound are packed with gauze.

To put this portion of his essay in his own words as they have been a source of controversy, he says: "So suche ich bis ins Mittle ohr zu gelanger um alles Krankhaft unter Leitung des Auges mit den scharfen Löfel entfernen zu können."

He reports his results as follows: In the preceding ten years he had operated 44 times on 43 patients. Of these, seven died, a mortality of 15.90 per cent., two from brain abscess, three from meningitis, one from pyemia, and one from collapse. The last case suffered from soor at the time of the operation, and was greatly reduced in strength, and died the day after the operation without fever with symptoms of collapse. The 36 remaining patients were commanded to

appear before Dr. Katz on December 20, 1888, but only 12 appeared. Of these, nine were completely and permanently healed; three with cicatrized tympanic membranes and preservation of hearing; three with perforated tympanic membrane but dry cavi. The hearing was reduced, but present in three. In three the audition was diminished. In one audition was absent before the operation and was unimproved after. In two cases the tympanic membrane and ossicles were absent; the cavum dry. In three cases suppuration continued; in two cases from the ear, the outer wound having healed; in the remaining case, that of a child, with multiple tuberculosis, the ear was dry, but a small fistula remained externally which healed after a slight secondary operation. Therefore, there were ten cases cured, or 83.33 per cent. Of five other cases of which he heard, three were permanently and completely healed; one, however, after a second operation. The other cases died of pneumonia several weeks after operation; the other died after four years with symptoms of meningitis. Of seventeen patients, thirteen were completely healed, that is, 76.47 per cent. The duration of the after treatment in most cases was from four to eight weeks, the longest seven months.

Von Bergmann's publication followed Küster's. The technic was largely the same as in the latter group of cases, except that he not only removed the posterior wall of the auditory canal, but the superior wall as well, together with the outer wall of the epitympanic space.

Following the appearance of these two papers the rational surgical treatment of suppurative ears took on new life, enlivened by Kuster's pastulate: "Ein rationelles chirurgisches Verfahren muss von dem Grundsatze ausgehen, den Knochen breit und ubersichtlich zu eroffnen alles Krankhaft zu entfernen und die Enter quelle so voll komnen frenzulegene, dass der Eiter nirgends in seinem Abfluss behindert ist."

Schwartze's clinic was an active center in this advance and to one of its members must be ascribed the honor of establishing the next milestone of progress.

Stacke published his first paper in the Archives für Ohrenheilkunde, Vol. 31. The technic of his operation was as follows: After the external incision, the membrane of the external auditory canal was detached, and the external wall of the epitympanic space removed. At this point endeavor was made to ascertain whether the disease lay most in the cavum or in the mastoid process. In case there was not a large cavity or dead bone found posteriorly, extenteration of the cavum was performed and the operation finished. In case, however, the mastoid was found diseased, penetration of the antrum was made either through the posterior wall of external auditory canal or from the surface as in Schwartze's method. Thus the diseased cavity in the mastoid, the epitympanic space, the cavum tympani and the external auditory canal were made into one large cavity. Stacke was the first to make a flap from the external auditory canal with which to cover the denuded cavity thus made.

We cannot abandon this portion of the history of the development of the surgical technic without referring to a brief contribution made by Dr. Carl Wolfe of Hersfeld, entitled, "On draining the Mastoid Process," which appeared in the Berliner Klin. Wochenschrift, in 1887, No. 15. Although his work was done upon the cadaver, to my mind it, in its simple way, forestalls much of the work that was done afterwards by Küster, Zaufal, Stacke, and others. It is so important that I shall herewith append nearly the entire paper.

Wolf begins by calling attention to a paper by Dr. A. Hartman who published the results of an examination of 100 temporal bones with reference to perforating the mastoid process. He came to the following conclusions:

1. Der Canal soll nicht weiter nach aufwarts als in die Höhe der oberen Gehörgangswand gelegt werden.

2. Der Canal soll nicht hinter der Anheftungslinie der Ohrmuschel gelegt werden.

Wolf says that as this area, owing to its smallness, can only

be opened by a small trephine, he made the following observation on the cadaver in order that a chisel might be used, which is safer.

Schnitt in der anheftlungslinie der Ohrmuschel. Das Periost wird abgeschabt und als dann der knorplige Gehörgang an der hinteren wand vom knöchernen getrennt und mit einem langen, schmallen Hacker nach vorn gehalten. Nun fängt man on dem äusseren Rand der hinderen Gehörgangswand an zu meisseln und dringt von da immer weiter nach der Paukenhöhle vor, indem man von der hinteren Gehörgangswand schichtenweise abträgt, als wohl man emfach den Gehörgang nach hinter erweitern. * * * * Die Zwischenwand zwischen Autrum und ausseren Gehörgang is 3-4 millimeter breit; es gelingt leicht auf die angegebene Art sie zu durchbrechen. Die Paukenhöhle wird wohl auch unter den schwerigsten operations verhalnissen kenntlich sein und weiss man also genau bis wie weit man in die Tiefe vordringen darf. Am ausseren Rand der Gehörgangs kann man bis zu 15 millimeter Dicke von der hinteren Gehörgangswand wegmeisseln, es wird also unter allen umständen ein hinlänglich weiter Trichter geschaffen, in dessen Grund man Sehend operiren kann. * * * * *

Nach Eröffnung des Antrum wird dasselbe ausgesportzt. Der obere Theil der Hautwunde wird genäht, in der unteren Theil legt man einen dünnen Drain, whelcher bis zu Antrum reicht. Durch diesen Drain Spritzt man täglich einmal ein schwache Carbol—oder Salicylisäure—Losung. * * * *

An important modification of the radical operation was published by Jansen in 1893 in the Archives fuer Ohrenheilkunde. In selected cases with good hearing, where he believed that the disease lay largely in the mastoid, after the primary incision he exposed the diseased process in the mastoid, took away the posterior wall of the external auditory canal and epitympanic space, leaving the ossicles and tympanic membrane, made a flap from the external auditory canal, sewed the posterior incision, and packed from the external auditory canal.

It may be seen from this brief consideration of the historical development of the technic, that advancement has taken place along two lines: One in which the contents of the cavum are preserved; the other in which the sound conducting apparatus is removed along with the diseased area in the mastoid. For years the latter mode of operation has received the almost unanimous support of operators for chronic cases.

Recently Heath, of London, has drawn attention to the former mode of operating. Heath read two papers. The first was read before the Otological Society of the United Kingdom, and published in The Lancet for December, 1904, and was entitled, "Restoration of Hearing after Removal of the Drum and Ossicles by a Modification of the Radical Mastoid Operation for Suppurative Ear Disease."

It is difficult to perceive in what his modification consists, unless it be the rubber sheet and clamps with which he covers the head of the patient, or the forty-five instruments which are illustrated, including the hair comb. He does, however, "remove the projecting part of the stapes with fine nippers." In short, his radical operation is the same as that performed by competent operators the world over. The ossicles are removed, the external wall of the epitympanic space removed, and the cavum, attic, antrum, and external auditory canal are made one cavity, yet he says: "I have shown you several patients this evening that have been operated on by me in the way I have described in this paper, and mostly for disease endangering life. You have seen that they have no ear drums; that they are not disfigured; in some you cannot even discover where the incision was made. They can hear a voice, a whisper, and a watch. They have been cured of the suppurative disease which endangered their lives as well as their hearing, and for all practical purposes they can hear as well as the majority of ourselves. . . . Some have obtained situations, and their employers have never even known that they had undergone this operation, and that their drums had been removed. Others being

discharged from their situations for deafness have been reinstated as soon as their hearing has been restored by the operation I have just described."

In his paper entitled, "The Treatment of Chronic Suppuration of the Middle Ear without Removal of the Drum Membrane and Ossicles," The Lancet, April 27, 1907, he says: "The aim of the radical operation, however, . . . is to get the discharge stopped, with the certainty of a defective ear."

With the technic of the operation which he described in his second paper, you are all familiar. It is hardly original in principle or minutiae, yet on account of the wide interest it has stirred up, it is well for us to consider at this point the feasibility of such a procedure. It is a self-evident proposition that only in rare cases of acute disease with cerebral complications, is the radical operation to be considered. Only a chronic suppurative inflammation, therefore, can be discussed in this relation. From my own experience, I should say that the Schwartze operation or the meato-mastoid operation is insufficient in the large majority of chronic suppurative diseases, which demand operation. An idea of the condition of the cavum tympani and its contents in chronic cases, without cholesteatoma formation, may be gained from the 113 cases published by Grunert in Schwartze's clinic; in only five of these cases was the tympanic cavity found free from caries. Of the other cases, in 21 the ossicles were carious, in 87 the walls were carious, and of these, caries were found in the tegmen tympani in 14, and on the promonotorium in 15. Once there was a fistula leading from the antrum to the semi-circular canal; twice a semi-circular canal-aditus-fistula; in 108 cases the ambos was carious, and the hammer in 76; both together 76 times.

It is very difficult, if not impossible, to ascertain the condition of the walls and the contents of the cavum tympani and attic without operative exposure. Where the sound conducting apparatus, malleus and incus, are bound down

by adhesions; where the stapes in ankylosed; where, before operation, there is demonstrable necrosis of the walls of the cavum or ossicles; where the epitympanic or zygomatic cells are involved, it will do no good but rather harm to the hearing to attempt to retain the sound conducting apparatus. Where the antrum is obliterated and the dependent cavity in the mastoid is in communication with the cavum only by means of a narrow fistula, as occurred in two of my cases, neither the Schwartze nor the modified radical operation is possible,—the Stacke operation is the only one permissible here. We see, therefore, that the Schwartze or modified radical operation in the treatment of chronic suppuration has a very limited field. I mention the Schwartze and the meato-mastoid operations in conjunction, as I believe we can get as good results from one as from the other in those cases where the disease in the cavum is insignificant or dependent on disease within the mastoid. It goes without saying that in all cerebral complications, or in involvement of the labyrinth, the freest exposure of the operative field is the only method to be pursued.

I have not considered ossiculectomy in the treatment of suppurative ear disease because it is aside from the point in question.

Discussion.

Dr. Emil Gruening, New York: I hope that I am not speaking from the point when I say that in the historical presentation of the mastoid operation we have to show not only what the results of Küster's and Bergmann's work upon the chronic cases was, but also what the results of their writings have been upon the treatment of acute mastoiditis. Dr. Pierce says the opening of the antrum was satisfactory and the cases did well; I would say that the opening of the antrum alone was unsatisfactory and the cases did not do well, and I practiced at that time. I treated my cases one, two, three and four years. Now that was very unsatis-

factory. Schwartze said the apex must never be touched, because it contains diploëtic tissue. He very much retarded the development of the operation by that statement; not that I mean to detract from what he has done in other respects. The modern mastoid operation has been developed in America. The systematic removal of the anterior wall and apex was first done in America. When in 1891 an article appeared in the Transactions of this Society, stating that it was necessary to remove the anterior wall and the apex, the criticism in the "Archiv für ohrenheilkunde" was very unfavorable, and that criticism has never been retracted. I wish merely to mention this in connection with the consideration of the development of the mastoid operation.

Dr. B. Alex. Randall, Philadelphia:—I should like to cite another point which seems to me important in its bearing upon what Dr. Gruening has said as to the American development of the mastoid operation, one that has been to me a most important part of the work, the anatomical side, as presented by Leidy and other men since, as being in a sense the crucial line along which has crystallized much of our work. I think Leidy was the first, in his paper on "Science" in '73, who made it clear and emphatic that beside the 'antrum' or tympanic cavity proper in relation with the drum-head, we have the attic space above (the epitympanum) and the antrum, as the three-fold constituents of the tympanic cavity. There is a great amount of confusion still shown by many men in writing about the 'tympanum,' meaning thereby the drum-head, while most of them mean only the tympanic cavity proper; and they have little or nothing to say about the epitympanum, still less the antrum, regarding it is separate. The idea which Leidy so positively brought forward and insisted upon seems to me a crucial one in this work, that the antrum is not properly to be called the mastoid antrum, but the tympanic. This is a very essential matter in the proper understanding of and dealing with these cases, particularly in the modern development of the work.

Schwartze only with the publication of his text-book in '93 brought out clearly the differentiation between the chronic and acute cases, which Dr. Pierce has spoken of; and it has only been since men realized more fully the relation of the antrum as tympanic, and that in their operations, particularly in chronic cases, trying to eradicate the trouble they had not only to drain the antrum, but all the tympanic cavities, that the operation has been placed upon its proper basis.

Before I had seen anything of Küster's writing, twenty years ago, I did the complete operation, based upon anatomical knowledge of the parts. I was indebted to Wolf more than to any other operating surgeon in this matter. Today Bryant deserves as much mention as Heath for the operation without removing the drum-head and ossicles.

In regard to the Schwartze-Stacke operation it should be borne in mind that what Schwartze first did in modifying the Stacke operation, which was done through the canal, was to put a narrow hole through the mastoid in which to stick his protector. Instead of using the margin which is nature's protector, he bored a hole through what he himself supposed was normal mastoid in order to employ an unnecessary instrument, to avoid the 20% of facial palsy which at first befell him.

Another American who deserves credit in this matter, both for his work and for his phraseology, is Dr. J. Orne Green. When he gave us the term **mastoid exenteration** for the simple cases and **tympano-mastoid exenteration** for the so-called radical operation, he put the matter before us in words that are unmistakable and that should be used with far more uniformity than they have been. It is a tympanic or a tympano-mastoid exenteration that we want to do in the case of chronic suppuration if we want to get at the real condition. I feel that this matter of proper nomenclature has been a real contribution to the subject. The term that Leidy uses of scute for the wall of the attic and antrum—so emphasized in the infantile bone, is also of great value. The idea has

been generally adopted, but not the name—all recognize that this wedge of the squama must be removed. These are essential points in the development of the subject.

FURTHER MASTOID OBSERVATIONS:

THE EXTERNAL OPERATION OF RARE NECESSITY; THE INTERNAL OPERATION OF GREAT UTILITY.

By SARGENT F. SNOW, M. D., Syracuse, N. Y.

Mr. President, and Fellows of the Society:

There are two sides to every question, so I am constrained to again open the unpopular, conservative side of the Mastoid subject. Pardon me, then, if I make free use of the personal pronoun.

I believe the time is past when it is dangerous for us to question the sanctity of the radical, post aural operation for the relief of simple pain, tenderness, and swelling in the mastoid region. As recent as 1905 the external operation seemed to be held as sacred and to question its propriety was rank heresy.

I well remember the vigor with which I was attacked at Pittsburgh in 1898, during a discussion before the American L. R. & O. Society[1], when I advocated a more general conservatism in Mastoiditis. I also remember the hours of anxiety I spent after reading an article on "Conservatism in Acute Mastoiditis" before the American Medical at Saratoga in 1902[2], when the "Powers that Be" were considering the proposition to exclude my paper from the publication, or worse. Then again the following year, the President of the Otological Section asked to look over the article I was to present under the title of "Drainage and Ice in the Early Stages of Mastoiditis"[3], fearing, I suppose, that it might

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1—P. 104 Trans. of the A. L. R. & O.

2—P. 26 Jour. A. M. A.

3—P. 165 Jour. A. M. A.

be unsuited to the sensitive ears of those times; but now, men who have conservative views on Mastoiditis, I hope are not looked upon as Anarchists with something dangerous to promulgate.

With a free drainage obtained by an incision from the lower border of the membrani tympani, upward through the posterior segment and attic folds to the bone, and outward along the posterior superior canal wall, we at once answer nature's call in relieving pent up secretions, and place the patient in an attitude of recovery so surely, that no criticism should be made on a man who does this promptly, and then treats his patient on the expectant plan for twenty-four to thirty-six hours.

Allow me to say, that in an experience of fifteen years with these conservative methods in two hundred well marked mastoid cases, I have been forced to the external operation but three times, in cases where absence of extreme mastoid, or cerebral symptoms justified conservative attempts, either in private or hospital work. In one bad case of measles in a child three years old, showing late in the disease mastoid tenderness and swelling, I promptly made the internal incision described, but warned the interested parties that an external operation might be necessary, as dull, listless periods had been noted by those who gave me the history. As the periods of dullness continued, we did the complete, post aural operation, finding healthy mastoid cells, but a low grade meningitis developed, possibly from an infection through the tympanic roof before our internal drainage was secured, and death followed two weeks later. The two other instances were in males where recurring attacks were frequent, and even continued after a thorough clearing out of the mastoid cells and attic, both these cases later responded to physiological doses of Iodide of Potassium. I have had no other deaths in mastoid cases, except in consultation practice, where the cases presented, at my first examination such active symptoms, that nothing but the freest external and internal drainage could be accepted as proper treatment.

R. W. Seiss of Philadelphia, in a discussion at the American Medical Association at Atlantic City in 1904,[4] stated that out of six hundred cases, he had operated but thirty-five times, and had only five deaths, all of his five hundred and sixty-five patients not operated upon recovered.

In no case where I have attempted conservative methods, have I had intercranial complication, except in the child mentioned, and in that case, the complete post aural operation was done unnecessarily.

A diffuse cellulitis extending over the parts late in the disease, is the cause of many unnecessary operations upon the mastoid. In fact, our judgment may be taxed to the utmost in these cases, deciding whether to open externally or not, as the tenderness and swelling often extends well down into and along, the vessels of the neck, and simulates closely that of an involved lateral sinus, but the temperature jumps and variations are absent.

Without extreme or complicated symptoms, the mere fact that upon opening we find pus in the antrum cells, does not justify the jeopardy in which we have placed the patient by the anaesthetic used, operative and postoperative infection, and a possible malposition of the lateral sinus.

In this connection, allow me to emphasize the point that a large sharge of the battle depends upon the nurse in attendance having a full appreciation of what you are trying to accomplish. She must understand that orders for constant **hot** applications means **steaming hot**, not **warm**, and for constant **cold** applications, means **ice cold**, not **cool**. If she does not render faithful service, the drainage we get by both internal and external operating, is none too good in the severe cases following La Grippe. Conservatism in these, without efficient nursing by one we take time to train, is too risky a proposition.

Another point to be emphasized, is that the vitality of these patients is still low, even after all active symptoms, and

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4—Seiss: P. 184 Trans. A. M. A.

perhaps discharge has abated, and if we allow them to take up their daily routine before their resisting powers are recovered, they are apt to have returning activity of their catarrhal states, a new intratympanic retention will take place, a reinvolvement of the mastoid will be manifest, and proper drainage will again have to be obtained. This new inflammatory state is not due to a fault with the methods originally employed, but to adverse circumstances attending the convalescence, and we must again renew our efforts.

You may ask when I would do the external operation. My answer is, within twenty-four to thirty-six hours, if no decided relief is shown from our free internal incision, proper nursing and ice. Each operator must be the judge whether his drainage is adequate or not.

If a swelling of the soft tissue closes the external auditory canal so much that it interferes with the drainage secured by the internal incision, it may be necessary to do the external operation, but in most instances, reincising the walls of the canal, followed actively by hot stoups and irrigation, will relieve the situation.

Allow me to call your attention to the fact, that an incision in the posterior half of the drum to be depended upon, is not simply a cut in the drum membrane, but is carried by a strong knife, well up to, and outward along the bone, accomplishing internally, what a Wilde's incision does externally, besides giving the attic and mastoid antrum needed relief of pressure. Its simplicity and safety commends its general adoption as an ever ready first aid to the afflicted.

A general anaesthetic is not needed, as it can be made quite painless by a local application composed of cocaine, menthol and carbolic acid crystals in equal parts, dissolved in glycerine, that I recently saw used by Prof. Luc of Paris in his private work.

If the knife has parted the reduplicated attic folds properly, there is no doubt that the drainage obtained, if maintained, is adequate for almost all acute cases of mastoid

involvement, and I am repeatedly surprised how acute exacerbations in chronic mastoiditis, promptly responded to the same measures.

The changing positions of the patient and capillary attraction, makes what would seem anatomically a poor drainage, a markedly efficient one, if the outlets are kept free.

This internal operation through the drum, attic folds and canal, can be done at our first examination, where there are local evidences of inflammation in states varying from a slight bulging of the tympanum, to the more advanced stages where there has already been a rupture, but there is still evidence of poor drainage.

No preparation is required, except twenty to thirty minutes for the local anaesthetic to become effective, and immediately after it is done, the patient is in a condition where drainage is so free, that at least ninety-five per cent. ought to recover, and a full return of hearing be secured. After free drainage is obtained in cases with no cerebral manifestations, we can expect benefit and comfort from the applications of cold. The Sprague ice bag may be used, not only for forty-eight hours, but for days, if the activity of the symptoms is subsiding, continuously applied while used, but taken off if very disagreeable to the patient, and frequently hot stoups and irrigations substituted.

Our consultation practice, of course, brings us into contact with advanced complicated mastoid states, where the best drainage we can obtain by the external and internal operations, is none too good, and conservatism then becomes a crime, but the rank and file of our cases of mastoid involvement are acute in character, and respond with amazing alacrity if we open internally, and as I have said before, give nature a chance.

With every case of active middle ear inflammation, we have looming up before us the possibility of an intercranial involvement. Our whole hope and effort is to prevent this dire result, and there is no question but that the good drainage secured by the external mastoid operation, has mate-

rially reduced the frequency of intercranial involvement, and that the exploiting of this operation on that score alone, has been of great benefit to humanity; but now the question presents itself, can we not take a step farther, and prevent both mastoid and intercranial complications, by promptly doing the internal operation on the ear. My own experience teaches that we can, and in support of this, I would remind you that some ten years ago, Sir William MacEwen, at a meeting of the British Medical Association at Leeds, in speaking of operations for intercranial suppurative disease, made the assertion that these brain operations should never be required. For, said he, "Had earlier and better treatment of the ear condition itself been carried out, the intercranial mischief would not have occurred." Accepting Sir William MacEwen's assertion, that the key to the whole intercranial situation lies in the earlier and better treatment of the ear condition, a great field for high class effort is before Otologists.

It gave me much satisfaction in 1904 to hear Urban Pritchard, President of the Sixth International Otological Congress, in his retiring address before the Seventh Congress at Bordeaux, speaking of the radical mastoid operation, state as follows: "I venture to prophesy that before many years have elapsed, mastoid operations will, I was going to say, have almost become things of the past; but that might be going too far, but they at least will be far less frequent. Partly because of the greater perfection in the treatment of middle ear suppuration, and partly to our patients understanding the importance of early attention to discharge from the ear. I am glad to believe this, he continues, for grand has been the result of this post aural operation in the saving of life, still the subsequent conditions are not always quite so satisfactory as some enthusiastic surgeons perhaps may think." Dr. Pritchard even goes farther in this address, and says, "I heartily endorse the words of Prof. Luc, at our last Congress in London, when he said "That instead of being proud of saying 'I have operated on so many patients',

one should be prouder of saying, "I have cured so many patients without operation.' "

Such words and prophesies, gentlemen, coming from a man appreciating his responsibilities as retiring president of so illustrious a body as an International Congress, have a significance and weight that we should not ignore, and fortifies us in our efforts toward proper conservatism, bringing us back to our first proposition, that the external operation rarely becomes an actual necessity in Mastoiditis, if a free drainage by the internal route is established early in the disease.

Again allow me to say, that I have never had to operate externally on but three cases that I had deemed suitable for conservative attempts, and had only one death, and one death in two hundred cases is certainly not a high mortality.

To those whose custom it is to operate externally upon all their mastoid cases, I would ask that they try the effect of such an internal drainage as described, during the preoperative interval that usually exists between their first inspection of the case, and the time when consent of the interested parties is obtained for the external operation. Such an interval generally amounts to twenty-four hours, and in that time, free internal drainage ought to have at least started good changes.

The writer desires it to be clearly understood that he claims no priority or originality as to the internal incision, but as in previous papers, simply wishes to emphasize its great value and utility.

Discussion.

Dr. B. Alex. Randall, Philadelphia:—I think that the paper so distinctly meets the practice of the majority of us as to need little advocacy or support and really there are very few who come under the category defined by Dr. Snow as operating immediately upon every case of acute mastoiditis. There are some who simply could not get permission to do so if they would; there are more who from experience

have learned that it is not necessary; and while there are many who will, especially in discussion and unpremediatedly put themselves apparently on record as chiseling everything in sight, I do not know any such men myself and I question if there be in this society men who work with such a hair-trigger as that.

The point made by Dr. Snow as to the poor condition of many of these patients and the consequent possibility of relapses is well taken and should be borne in mind by all of us as discounting adverse criticism when these relapses occur. It is not of any necessity an evidence that the cases have been treated improperly.

The experience of men must of necessity vary with the material with which they are dealing. If I were working a good deal in the New York east side element I might be inclined to operate quicker than with my clientelle in Philadelphia; and it is distinctly different in our hospital work and our private practice. I have prided myself upon the number of cases I have brought through without operation, and that in spite of the fact that I was held up as a radical man. There was a time, in fact, when the majority of all the mastoid operations that had been done in Philadelphia had been perpetrated by one man; but now I am accounted probably among the ultraconservatives, and in Atlantic City last year I had to get up in protest when a paper read before the American Medical Association advocating conservatism was attacked as being a dangerous teaching and it was moved that it should be denounced by the section. I appreciate, therefore, Dr. Snow's view that there is scant welcome for any advocacy of conservative measures, although feeling that in this audience, at least, some of his remarks must pass by without touching any of the members. In point of fact there are ultra-conservatives and ultra-radicals in word, but in deed we do pretty much the same thing and I think none of us are 'commercial' enough to operate when we do not see a clear necessity for it and I think we all act in the matter as we would if the patient were a member of our own family.

A point that should not be overlooked is the conservation of hearing that is often due to a fairly early operation, as has been urged by Arthur A. Bliss. We may bring some of these cases through with a success that is more pitiable than failure; we may bring them through without operating, but with impairment of hearing that cannot later be remedied. I stand distinctly on the conservative side of this question and believe that there are those who operate where I would not; but my feeling is that I may also have erred in this respect. I have put myself on record as having operated upon less than one quarter of the cases presenting the classical symptoms of mastoid disease which many seem to regard as sufficient to justify operation; but I do not allow such conditions to continue, as Dr. Snow has said for more than 24 hours or so. I put the patients to bed and use hot applications rather than cold and have been so far fortunate that it is only about once in two years, in a case entirely within my hands, that I am forced to external operation, and I see a fair number of acute cases with severe mastoid symptoms every year. I think that speaks for pretty fair success. Of course in a number of cases there is no question as to the advisability of operating just as quickly as possible. As to the operation I feel that it is hardly a doubling of the danger of the anaesthetic, that is not negligible but is so small that we do not generally consider it. I think it fair to put it that way to the patients. I would not submit my own ear to operation without a distinct reason and would not submit others. I have records of about 2,000 cases with symptoms of redness, tenderness, sagging of the posterior wall of the canal, the classical symptoms for operative interference, which I felt could wait at least 24 hours and which so far as I know have waited until this day without recourse to external operation.

Dr. C. R. Holmes, Cincinnati:—I would like to ask Dr. Snow whether all of these 200 cases presented the classical symptoms? I heartily agree with the statement that the time

has come when we should probably be more conservative than some have been in the past; at the same time I cannot quite bring my records up to those of the essayist. If we mean ordinary acute otitis media with redness and bulging of the drumhead, I do not classify these cases with mastoiditis. If we mean cases where there is fever and evidence of pus in the mastoid cells, I should certainly not be able to show 200 cases of that kind treated without operation.

That some men do operate much more than they should I of course know. I know of one man in the middle west who said he had operated on 40 cases when I had only seen three and he did not have a very large number of patients to draw from, but he told me that he operated on everything that had acute inflammation of the ear. That of course is the kind of operator we want to aim our argument against. But, I take it that we have only one standard. With the knowledge we have, anatomically and clinically, would we be willing to submit our own ear to the operation? When we can say we would we cannot go far amiss in operating. I have always been opposed to the use of ice because to me it appears irrational. I cannot see how it can do any good in reducing the inflammation going on in the deeper part of the bone cavity. Naturally we resort to immediate and extensive paracentesis; nature never makes the opening sufficiently large or in the right place, and so we do not depend upon nature, but make a free incision. I have made it a few hours after pain began in order to head off any complication. But, nevertheless, I have not been able to reduce the number of operations to anything like the essayist mentions. As Dr. Randall says, of course it makes a difference whether you operate a good deal among the poor or among the upper classes.

As to the cocaine, menthol and carbolic acid mixtures, I have given that up; the carbolic acid injures the epithelium of the drumhead and complicates matters afterwards.

As to the hot douches I always use them, but do not use hot fomentations over the ear. The douches are used until such time as it becomes evident that they can do no good.

I do not object to the external operation on the ground that it interferes with hearing. I do not think I have ever had a simple operation where it interfered with the hearing, if I only went as far as the antrum. As to the danger, it is comparatively small.

I believe in conservatism in all things, but do not believe the external operation dangerous and it should not be restricted as much as Dr. Snow suggests.

Dr. Emil Gruening, New York: I do not know what practice is up State, in the region from which Dr. Snow comes, but the radical practice of operating on everything that comes along doesn't exist in the localities with which I am acquainted, and it doesn't exist in New York. There is no such thing.

I operate in public. Every case I operate on is viewed by men who know, and when I expose a mastoid there is pus and carious bone, and it is not a case of simple otitis media. Dr. Snow had cases of simple otitis media.

Dr. H. O. Riek, Baltimore:—The paper does not strike me as so conservatively conservative as the abstract would lead one to anticipate, and the closing remarks of the essayist rather take the sting out of the preamble, when he tells us that the 200 cases are selected from a large number in which mastoid symptoms were observed. We could all select 200 cases of acute suppurative otitis media with evidence of mastoid involvement which have not come to operation or in which only a small percentage have had to be operated upon. And, the writer admits having operated upon a large number that he does not include in this report. It is not fair therefore, to say that out of 200 mastoids only three came to operation.

A member of this Society, Dr. Hammond, several years ago reported a series of cases observed in the Massachusetts Eye and Ear Infirmary, cases of suppurative otitis media in

which there were symptoms of mastoid involvement, of which, under treatment, 70% did not come to operation. Now Dr. Snow claims that 90% would not come to operation by this form of treatment. It may be that he was dealing with a different class of patients. Dr. Hammond, for instance, was dealing with dispensary patients and I do not know whether Dr. Snow's cases were collected from private practice or not, but they probably were.

Dr. Randall has called attention to the fact that many of these cases of so-called cures are really in a worse condition than had they been operated on, in that the hearing is materially impaired. There is still another point to which attention might well be called; that is, that not all of these cases are brought through successfully which are temporarily relieved or cured. Does Dr. Snow know what became of all of the cases supposed to be cured? How many possibly turned up later in the hands of some other surgeon for operation? This month I have seen a patient from New York who had precisely this line of treatment; incision in the tympanic membrane on two occasions, and once extending into the posterior superior wall, and he was said to be cured and was discharged but later operated on for evacuation of an extensive extra-dural abscess. I know of another case occurring at my home where a man was treated without operation in a hospital, discharged as probably well, but turned up at another hospital later with lepto-meningitis. I could report a number of these cases that have come under my observation where the patients have been supposed to be cured, by so-called conservative measures, and came later to operation.

Dr. Roberts, Passedena, Cal., asked if Dr. Snow took smears of the discharge in these cases and whether his treatment was identical in all cases, irrespective of the nature of the infection, and whether the results were identical irrespective of the invading organism.

Dr. Hiram Woods, Baltimore:—The question of vital importance is: What justifies the diagnosis of mastoiditis?

An otitis media with very definite symptoms of mastoid involvment may get well, and the mastoid symptoms disappear, with free tympanic drainage. Has the patient had mastoiditis? I doubt it. We are in a position of uncertainty in these cases, similar to that of the general surgeon in cases presenting symptoms of appendicitis. A man that has tenderness in his right iliac fossa does not necessarily have appendicitis; and yet the operator will often go in and find a diseased appendix when the symptoms have been slight. Again, with apparently grave symptoms, he finds little or nothing; certainly nothing that demanded operation to save life.

Dr. Snow extends his line of reasoning to chronic cases; that is a very serious matter. When in a chronic case there is pain and slight elevation of temperature, there is still greater uncertainty, because the mastoid is eburnated. We are absolutely in the dark before operation.

Last week a boy with chronic otitis media (20 years of age) was admitted to the University Hospital in Baltimore with slight pain and a temperature of 99 to 100.5, a little oedema over mastoid and on the posterior canal wall, and a polypoid mass in tympanic cavity. He was not apparently in a dangerous condition. I operated on him, however, because I was coming down here this week. I found a large necrotic opening in the tympanic roof and another over the lateral sinus with the dura covered with granulations and pus in the mastoid antrum, shut in by ebernated cells. I think the patient would probably have died without operation and I should have delayed operation if I had not been coming to this meeting. Such patients make up a very different class of cases from those of acute mastoiditis.

Dr. Sargent F. Snow, Syracuse, (closing discussion):—I think that any subject that is a mooted question is a proper one to bring up. Dr. Randall offered the hope that there were few who would take exception to the paper. I did not dare have that hope because I have been under fire before

in this same matter and expect to get it again. I do not want to return the fire. I am simply willing to put the paper on record and let the future take care of itself as my experience has been so universally in favor of conservative measures in these cases of acute mastoiditis, not tympanic inflammation simply, but mastoiditis with the classical symptoms. When these reports were gotten out the instructions to the assistants were to select none but those having undoubted classical mastoid symptoms. I am sure that all had pus in the mastoid; in each there was bulging of the superior canal wall, marked tenderness, swelling, and temperature.

But don't think for a moment that I advocated delay in extreme cases. I only advocate that we make this internal incision when we first see the case and while getting ready for operation. That gives nature a chance, and as I have reported to you of 200 cases only three had to be operated on after such treatment was tried.

Dr. Duel:—About how many cases has the writer operated on in fifteen years, all together?

Dr. Snow:—Not over twenty perhaps; not less than fifteen. My experience has not been large in this operative field, I am proud to say.

As to whether I would obtain the same results again? I don't think I would. I don't think I could take another 200 cases and succeed as I have in years gone by, for I do not think I have the energy to get after the nurses and watch them in the future as I have in the past. In other words, I don't believe I would be as enthusiastic and diligent with another series of cases.

Dr. Harris:—What does the writer consider the particular qualifications for a nurse over and above those of the ordinary trained nurse?

Dr. Snow:—One that will follow your directions. If you want to apply ice you must have a nurse who will see that it is properly done and that hot the applications are kept

at proper temperature. If you want hot stoop and the nurse puts them on simply warm it is a waste of time.

I agree with Dr. Woods that we should be very careful in the chronic cases and not rely upon these conservative methods. I simply mentioned that some chronic cases with acute exacerbations, did well after a free internal incision of the posterior superior wall.

THE NON-ACOUSTIC FUNCTIONS OF THE LABYRINTH: A REVIEW OF OUR PRESENT KNOWLEDGE OF THE ORGANS OF STATIC AND DYNAMIC EQUILIBRIUM.

By PERCY FRIDENBERG, M. D., New York.

In presenting to this body a compilation and abstract of the work of others in the form of an historical review and a formulation of our present knowledge of the function of the inner ear in relation to equilibrium and orientation, I feel the requirement of justification. My plea is the subject itself, which is one of increasing interest and growing practical importance. Incomplete and hasty as the review must be in the time at my disposal, a sifting of the evidence and a summing up from the standpoint of practical otology may not be without value.

The history of systematic and scientific investigation of the physiology of the inner ear and especially of the complex function of equilibrium dates back for over a century. The questions involved are so intimately related to other chapters of physiology, notably of the visual perceptions, the sense of space, direction and position, and they are so often suggested by the practical experience of the clinic and operating room, that workers in the most various fields have contributed to our present knowledge. We have the

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The writer has made free use of the chapters on equilibrium and functional tests in W. Nagel's Handbuch der Physiologie des Menschen, Vol. v, 1905, and Geo. Boenninghaus' Lehrbuch der Ohrenheilkunde, Berlin, 1908, many passages being cited verbatim, especially from the last named excellent treatise. The anatomic details follow Schwalbe, Anatomie der Sinnes-Organe, in Bardeleben's Handbuch, Jena, 1905, with modifications after recent writers.

exact and careful animal experiments of Purkinje, Flourens, Goltz, Ewald, Breuer, and many others; the clinical observations of Lucae, Bezold, Ménière; the operative findings of Schwartze, Jansen, Hinsberg, Passow, Kipp and Burnett; the neurologic investigations of Bechterew and Baginski; the patient elaboration of tests by v. Stein, Barany, Krotoschiner, Koranyi; the studies of the functional defects of deaf-mutes by James, Bezold, Kreidl, Mygind, and the psychological applications and analyses of Cyon, Muensterberg and Warren, while in the important field of visual equilibration we are indebted to Helmholtz, Hering, Aubert, Delage and a host of physiologists for detailed tests of normal reactions and an arrangement of the varied data on the basis of uniform and simple principles.

Within the last ten years the literature in this wide field has become so voluminous that its mere citation would be impossible. It follows of necessity that many investigations have been omitted and others barely mentioned in my review. I have endeavored, however, to do justice to the subject by paying most attention to fundamental advances both in theory and practice and to the work of those investigators whose original experiments and observations have been most valuable.

The advance of clinical otology and particularly of its surgical branch has of late been striking and gratifying. One of the most important conquests has been the systematization of operative indications and technic in the surgical diseases of the middle and inner ear and their not infrequent intracranial complications. Many theoretical questions in diagnosis and symptomatology have been answered, and many anatomic minutiae learned, by the findings at operation and by the results, negative and positive, of surgical intervention. For the purposes of the aural surgeon the possibility of the application of all symptom interpretation, and of all diagnostic methods will depend in the last analysis on the degree to which they conform with and explain the manifestations of disease in actual practice. While we must admit this without reserve, there can,

I think, be no doubt of the value of continued study of function and its disturbance from the experimental theoretic side, no doubt that an elaboration and critical analysis of all rationally scientific methods will be of eventual service to the practitioner, and that the final result of accurate and painstaking investigations in laboratory and clinic will bring theory and practice into much desired accord and correspondence. The study of the functions of the inner ear and the systematization of functional tests is by no means complete, but enough has been done to show that we are moving in the right direction. The objections which have been raised to the errors inherent in this or that test, the exceptions to minor points of this or that theory are details, not fundamental, and cannot invalidate the principles involved nor prevent their eventual application. In fact, the practical objections of competent clinicians and surgeons can only serve a good purpose in correcting errors while they stimulate anew the search for the truth.

BIOLOGIC BASIS OF EQUILIBRIUM. TROPISMS.

A study of that complex of sensations and reflexes, of inhibitions and innervations, of conscious adjustment and automatic correction which is summed up and comprised in the term equilibrium, may be facilitated by reference to the simpler conditions existing at a lower level of structural and functional development. Biology has shown that there is present, and possibly inherent, in all forms of multicellular life, a tendency to show definite, and apparently purposeful reactions, so-called somatic reactions, to a large number of cosmic influences. In contradistinction to the visceral reflexes, which have to do with the internal organs and their functional response to stimuli in the form of such acts as swallowing, breathing and so on, these so-called somatic reactions consist in changes of position or attitude and may be produced by a number of agencies. As these agencies evidently act as stimuli, and the response motion

has the effect of altering the relation of the position of the organism to the source of stimulation, these changes have been grouped under the title of "tropisms," or turnings in a wider sense, and meaning not so much a rotation as a movement toward or away from the source of irritation. It has been shown, notably by Loeb and his school, that there is a uniform tendency to react to darkness and light by somatic alterations (heliotropism); to gravitation (geotropisms), to electrical current (galvanotropism), and to heat as well as to mechanically produced air vibrations (rhythmotropism). The varied changes of attitude and position can all be reduced, teleologically, to a simple formula or principle, the gist of which is that a final optimum of position is secured for the organism. This optimum may differ for various genera, species, and even individuals, but it is generally characteristic and imposed by the needs of the particular class, and by the desiderata of equal symmetrical innervation and a maximum saving of sensory as well as motor energy.

With increased complexity of structure and a differentiation of the body form into head and trunk, upper and lower, or abdominal and dorsal aspect, the somatic reactions to gravity become more and more accurate and delicate, and finally produce characteristic positions of balance and equilibrium both at rest (static) and in motion (dynamic). In higher animals, these automatic adjustments are found to be influenced by volition and as the cerebral hemispheres develop in the ascending series of animals, phylogenetically, there is evident an ever increasing domination, through inhibition and active innervation, by the will and by intellect. The highest stage of this domination, notably in man, includes the recognition of a summation of subjective sensations of an ego, as opposed to an objective something outside produced by a systematized externalization of perceptions. This process it is which finally produces the conception-complex of ideal space or direction to which we unconsciously refer, and with which we compare our motions

and sensations. Association, memory and habit combine to produce nerve paths of least resistance and to produce in sensory organs and cerebral centers so-called local signs, which may be defined briefly as definite conceptions of the relation of external agencies as cause, with subjective sensations as effect. Thus we have retinal local signs corresponding to different eye positions, and to different degrees of innervation of the ocular muscles, to accommodative states and to various points in space; cerebral local signs for all these data and for all of the varied sensory perceptions.

FACTORS OF EQUILIBRIUM.

The adjustment of the individual to space, equilibrium, and his recognition of that adjustment, orientation, is, in man at least, a complex function. Touch and sight, muscle sense, in its widest meaning, sensations of pressure or tension, of lightness or heaviness, in tendons, joints and viscera, as well as the feelings produced by consciousness of changes of states of hyperemia and anemia, all play a part. Nagel has shown that many of these agencies act so automatically that they may not enter fully into our consciousness, and special adaptations of conditions are required to exclude one or the other in the attempt to analyze and explain a single one. In fact it has been questioned whether this function of balance is a sense at all and whether it is not rather to be considered as an unconscious judgment-reaction of the sentient organism to the sum of sensory impressions. This question is of psychological rather than practical importance, and it has been found possible to make a fairly accurate and complete analysis of the functions of each factor. The part played by the visual organ has been studied with special ingenuity and exactness, and the work of Helmholtz, Hering, Aubert, Fechner and many others has finally given us a clear idea of the ocular function in space perception.

Stated very briefly and generally, there is a definite and

constant reaction to visual stimuli, having as its object the production of an optimum position of the eye-ball and clear central vision of external objects by means of macular fixation. This is expressed by a tendency to preserve the relation between verticality of the corneal meridian with verticality of external objects to compensate for inclination of these objects by an opposite inclination of the cornea, and secondarily but necessarily, of the retinal meridians. This correction is automatic and unconscious, and is complete for small degrees of inclination below 10°, that is, for alterations below the limit of perception. It is rather striking that this correction fails at a point where, as we shall see, another sensory-motor mechanism is brought into play by the mechanical conditions arising with higher degrees of inclination.

Fixation of objects at rest, a second and important factor of space perception, is a summation of all the ocular motions necessary to produce clear macular vision. The position of the fixed object is unconsciously judged not only by the stimulation-sense of the muscles engaged in fixation, but by a reference to the sense of position in our own bodies. There is here a definite interrelation of the subjective and objective, objects being referred to the known or felt position of the subject, and the position of the subject also judged, at least in part, by known positions, known that is from experience with objects in the external world. Fixation of moving objects also follows an instinctive tendency to bring them into the range of macular fixation. In the case of definite motions, that of objects progressing through space in one and the same direction, we can recognize two main divisions of eye motions. First, a rapid associated turning of the eyes toward the source of the moving objects, that is against their direction, real or supposed, for the purpose of catching that object on the macula. This motion, as has been shown by numerous experiments, is not associated with vision. In fact during this, recovery or compensation leap (the "Einstellung" of the Germans),

there is no clear vision whatever. The second motion is in the direction of the moving object and consists in keeping step with it, as it were, so that it is always in the line of sharpest vision. As this motion is regularly and invariably associated with a definite form of motion in external objects, its production, by any means whatever, will produce a sensation of such motions. It has also been shown that our knowledge of subjective motion is largely dependent on the feeling of eye-muscle-motion which accompanies the change of position in external objects. Numerous illusions of motion are due to apparent changes in the position of external objects. We are all familiar with the false sensation of moving in an opposite direction when in a stationary railroad train past whose windows a train of cars is slowly moving. We are largely dependent on our eyes for our habitual sensations of motion and change of position, and when deprived of these, as in the dark, our sense of motion direction may be greatly diminished. This is particularly true of rotation-motions and the lying position. Progressive motion, forward or backward, in the erect position, is uniformly attended by sensations of resistance or friction between the body and its support. The absence of these tactiles and visceral sensations, or their changed relations to our experience, accounts for the ease with which we can be misled, as to the direction in which we are moving when lying down, as at night in a sleeper or on shipboard.

Besides the definite subjective sensations produced by changes of position, we note definite somatic reactions, "specialized tropisms," we might call them, having as their conscious or automatic object the restoration of balance, i. e., the regaining of the optimum position, which we may assume is normally and habitually occupied. This adjustment is in the nature of a correction or compensation. It depends upon muscle motions, largely involuntary and reflex, brought into action by sensations or lack or loss of balance. It is significant for the safety of the organism that disturbances of the motor arc of this mechanism do not

vitally affect or seriously interfere with balance. Differences of muscle strength for instance, in the two sides, even marked irregularities, such as a flat foot or a sprained ankle, do not cause loss of equilibrium. There is probably unconscious adjustment for these factors, as there is for the unequal strength of right and left hand when both are used together in pulling or pushing. The sensory component, on the other hand, is of the greatest importance, as it is through the sensations of resistance that the varying degrees of muscle innervation are called into action, and as a matter of fact, disturbances of sensation, anesthesias, are particularly apt to cause confusion in somatic reaction for the preservation of equilibrium.

THEORIES OF THE FUNCTIONS OF THE LABYRINTH.

The striking anatomic peculiarities of the structures of the inner ear, the snail-shell whorls of the cochlea, the regular curves and geometric arrangement of the semicircular canals, and the suggestion of complex function and of necessary purpose afforded not only by structure but by their presence throughout a long range of the animal kingdom, attracted early attention and inspired investigation, while they seemed to hold, as it were, within themselves the answer to the riddle of their meaning. The arrangement of the canals, particularly, in three principal dimensions of space was at once felt to be of fundamental significance, and from the earliest years of modern scientific investigation we find this special relation as the starting point of theory. The most obvious connection was that with audition, and it was assumed that the three semicircular canals mediated sensations of sound coming in any of the three main directions corresponding to their axis, or analyzed atypical sound directions by proportional representation in the three dimensions. This theory crops up at intervals in the history of the investigation and has persisted until the present time. It is associated with the names of Autenrieth (1802), Cyon (1854), Brueckner (1888), Hensen

(1893). Many variations were played on this theme. The function was thought to consist in a destruction or dampening of tone-waves which had already acted on the auditory organs, sensu strictiori (Czermak, 1860; Malinin, 1866), in perception of noises as opposed to tones, i. e., non-periodic vibrations (Schiff, 1857; Hasse, 1867); in perception of muscle tones produced by contraction of head muscles and thus indirectly of position of the head in space (Bornhardt, 1872); by bone conduction of external sounds (Ogston, 1869), and with the purpose of directing eyes and ear toward the source of sound (Munsterberg, 1889). A teleological modification of this basic theory allowed the inference that a special sense of direction, acoustic stereognosis, as well as the homing instinct of animals was mediated by this apparatus. Among other theories which attribute a non-acoustic function to the labyrinth we may mention those of Cyon and of Hogyes, who believed that the nerve terminals in the labyrinth were intended to produce definite tetanic positions of the eye muscles, the 2x6 nerve endings being in communication with the 2x6 eye muscles for the purpose of producing unconscious eye positions which are not compensatory but reflex.

NON-ACOUSTIC THEORY (BREUER, MACH, CRUM BROWN).

The theory of a specific, equilibristic function of the labyrinth was based almost from the beginning on the results of careful experiments on animals and human beings, and accordingly progressed by slow and steady steps, rather than by leaps and bounds. Among the earliest observations were those of Purkinje (1820), on rotation and vertigo, and those of Flourens (1825) on experimental section of the horizontal semicircular canals. The latter investigator found in doves and rabbits that hearing was not affected, but that there was a typical disturbance of equilibrium, with characteristic compensatory movements of the head and body. Section of the other canals caused similar pendulum motions of

the head in the axis of the injured canal. Nearly fifty years later, Fr. Goltz, in Strassburg, took up the forgotten experiments of Flourens and repeated and extended them, showing that the compensatory motions were not forced motions and did not depend on auditory sensations, but were specific sensory reactions. The semicircular canals are the sense-organ for the equilibrium of the head and mediately for that of the entire body. The adequate stimulus is the gravitational pressure of the column of endolymph. A few years later, Breuer and Mach, in Germany, and Crum Brown, in England, suggested the modification of the theory of Goltz. The first named author called attention to the fact that the mechanical requirements of this theory could only be satisfied if the semicircular canals were suspended in a medium like air, of a specific gravity appreciably lighter than that of the endolymph, whereas, in fact, they are surrounded by perilymph which is of about the same density. The modification of Breuer and Mach consisted in the hypothesis of endolymph motion in place of endolymph weight-stress as an adequate stimulus, and this slight change was the corner-stone of a new structure. As the theory of Breuer and Mach with its adaptations to advance in experimental and clinical investigation is the most complete and satisfactory at present time, and as most of the clinical tests and diagnostic conclusions are based on acceptance of its fundamental assumptions, somewhat more detailed consideration of this theory may be advisable.

PLAN OF SEMICIRCULAR CANAL SYSTEM.

I shall not tax your patience with a description of the anatomy of the labyrinth further than to call attention to the fact that we have to deal with a bilateral, symmetrical structure. Each canal of a side corresponds in plane to a canal of the opposite side; thus the two external canals in the horizontal plane, the anterior or superior canal of one

side with the posterior or inferior of the other side. (Fig. 1.) It will also be noticed that the ampullar bulbs of corresponding canals are at opposite ends; this ampulla of the right horizontal being on the right, while that of the contralateral canal is on the left; the ampulla of the right superior canal being in front, above, and that of its synergist, the left inferior, being behind, below. Furthermore, the greater

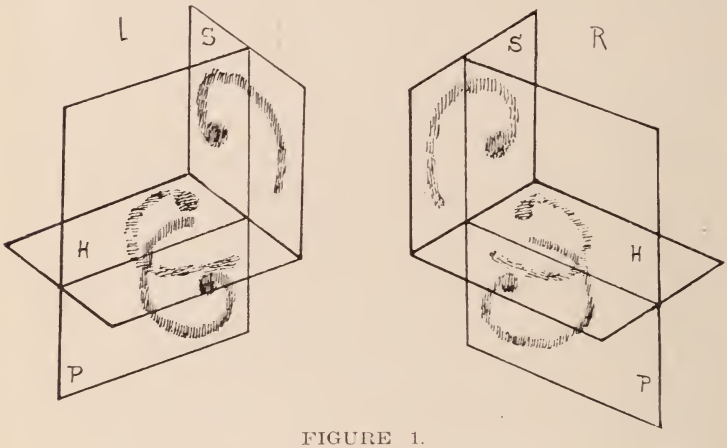


FIGURE 1.

Diagram. Relations of the Semicircular Canals (after Ewald). S. S., plane of superior or anterior; E. E., of external, horizontal; P. P., of posterior semicircular canals, seen from behind.

part of each canal is posterior to the ampulla, so that bearing in mind that the entire system is about on a level anteroposteriorly with the axis of rotation of the head, any rotational change will correspond to an opposite rotation of the corresponding canal. The practical significance of this arrangement will be pointed out in the analysis of the functional mechanism of the labyrinth.

ANATOMY OF THE LABYRINTH.

The membranous labyrinth (Fig. 2) containing the terminals of the vestibular branch of the acoustic nerve is

enclosed in a bony capsule, the osseous labyrinth, occupying the middle of the petrous portion of the temporal bone. In animals of the higher vertebrate class the structure is very like that in man. The sagittal axis of the system is directed inward at an angle of about 45°, and the horizontal canal is not in a horizontal plane, but inclined backward at about the same angle.* The posterior crura of the two vertical canals on either side join and enter the utriculus by a common port, so that there are only five openings instead of six. Each canal has a spherical enlargement, the ampulla,

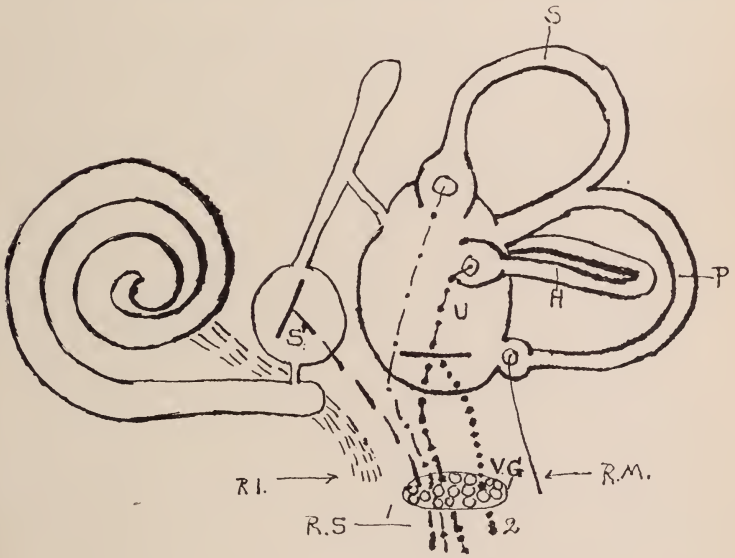


FIGURE 2.

Menbranous Labyrinth, left, seen from Outer Side. S, superior; P, posterior; H, horizontal semicircular canal. S1, sacculus; U, utriculus, with vertical and horizontal macula, respectively; R I, ramus inferior, Cochlear branch, of VIIIth nerve; R M, ramus medius, from posterior ampulla; R S, ramus superior; 1, first branch, from macula sacculi, superior and external ampullae; 2, second branch (utricular branch), from macula utriculi; V G, vestibular ganglion.

*This special arrangement of the so-called horizontal canal and of the maculae would indicate that the erect position of man has not existed long enough to influence these structures of the inner ear. They are still in the same position as those of the "beasts of the field which creep upon the earth."

at one end. Within this ampulla we find a prominence so marked as almost to occupy the central axis of the canal. On this crista we find sensory epithelium with long pliable hairs, not floating free in the endolymph, being held together by a gelatinous mass, the cupula terminalis. At two points in the membranous labyrinth we find, respectively a vertical and a horizontal collection of sensory epithelium, very similar in arrangement and structure to that of the ampullae, the macula utriculi and macula sacculi. The hairs are shorter and stiffer than those of the ampullae, are held together by a stiffer mass (otoconium), which, however is not gelatinous, but composed of the so-called otoliths ("statoliths" according to Verworn), microscopic crystals of carbonate of calcium. The rest of the wall of the membranous labyrinth has no nerve terminals, but gelatinous threads have recently been traced by Breuer from the wall of the utriculus to a drop-like accumulation of the same material on the otolith mass which they evidently nourish and renew. The plane of the macula utriculi corresponds to that of the external semicircular canal, i. e., in the upright position it is inclined backward at about 45°. The otolith plate of the sacculus, under similar conditions, runs at about the same angle from above and behind, forward and downward, in the anterior posterior plane, i. e., parallel on either side. In lower animals there is a third macula, the lagena, allowing vertical displacement of the otolith plate, while both utricular and saccular macula are horizontal, but at right angles.

NERVE PATHS AND CEREBRAL CONTROL.

The vestibular nerve (Fig. 3) starts from the ampullae, one branch (ramus medius N. viii) from the posterior ampulla going separately through the foramen singulare near the meatus internus, another from the macula sacculi, superior ampulla, and the external ampulla (first branch of ramus superior), through the upper portion of the terminal plate, and a third, utricular branch (second branch of ramus

superior), through its lower portion, through the vestibular, bipolar ganglion, which according to Hensen is the neurologic nerve terminal of the vestibular branch. The vestibular nerve now enters the pons and reaches the dorsal nucleus of the eighth nerve (Deiter's and Bechterew's nuclei). Here the peripheral neuron ends. The central

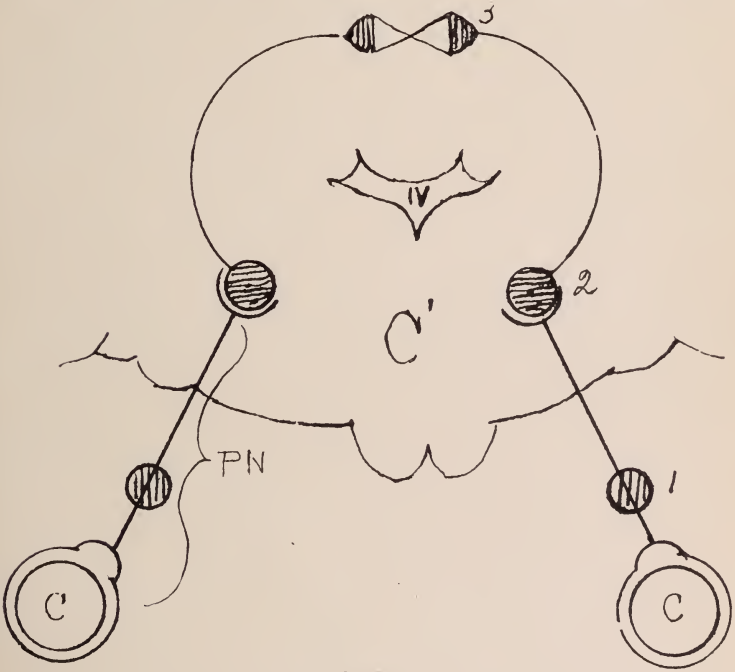


FIGURE 3.

Central course of Vestibular Nerve (after Boenninghaus). Diagrammatic cross section through pons and cerebellum. C C, Semicircular canals (vestibular apparatus); 1, Vestibular ganglion; 2, Dorsal nucleus of VIIIth nerve; 3, Nucleus tegmenti; P N, peripheral neuron; C1, Cerebellum; IV, Fourth ventricle.

filaments can be traced across around the fourth ventricle and the tegmentum or roof to the tegmental nucleus, most of the fibers going to the opposite side. This path brings the vestibular nerve into relation with the anterior columns of the cord and with the abducens. There is no known connection with the cerebral cortex. The cerebellar cortex is

intelligible as an indicator of degree of tonus, contraction and effort, in various body muscles, notably those of eye and lower extremities, established voluntarily by the brain, or by reflex from tactile, muscle, visual and balance sense, to preserve body equilibrium and possibly reflex fixation of external motion. In time it would become as we know of the cerebral cortex, a store house for memory-pictures of sensation-states connected with eye-motion, tactile impressions and muscle tonus, in their relation to balance and the perception of motion, direction, rotation and the conception of ideal space, and would thus aid in regulating subjective sensations by referring them to a common standard of tradition, experience or memory. A discrepancy of signals received at a given time, whether from eye, tactile or muscle sense, or balance centers in labyrinth, either with each other or with memory standards, would produce the effect of a contrary innervation and the markedly unpleasant subjective sensation of confusion which we call dizziness. The unconscious judgment factor in complex sensation of balance and its disturbance in dizziness is shown by the gradual development and increase during life of the capacity for both, the susceptibility of highly organized and trained intellects to dizziness, the comparative immunity of children and stolid, phlegmatic, illiterates, and the ease with which the sensation of disturbed balance or dizziness can be elicited by slight modifications and confusions of visual impressions. This is particularly the case with the swinging mirror which produces almost immediately a feeling of marked vertigo and even nausea.

The labyrinth is in connection with the ocular muscles presiding over abduction to the same side, i. e., external rectus of the corresponding eye and internal rectus of the opposite eye; the occipital muscles and trunk muscles of the same side and with lateral rotators of the head to the opposite side (Marikovszky, 1904, rabbits). The connection with the oculomotor nuclei and the anterior horns of the cord runs through Deiter's nucleus (Adler), and the central end station for centripetal sensory stimuli is situated in

the cerebellum. According to Stefani, the cerebellum is a central organ whose activity is principally stimulated and maintained by impulses emanating from the labyrinth and whose function consists in the preservation of muscular tonus which is required for the maintenance of a stable body position in normal equilibrium. The cerebellar cortex is not to be considered as the center for sensations of motion and position (Lange, Nagel). The labyrinth, besides its function in maintaining tonus, mediates these sensations and it is to be assumed that they have a representation, in some cortical area, but this area has not yet been determined.

THE MECHANICS OF LABYRINTHINE FUNCTION ACCORDING TO BREUER AND MACH.

With every rotation of the head the endolymph contents in the semicircular canals lags behind on account of inertia,

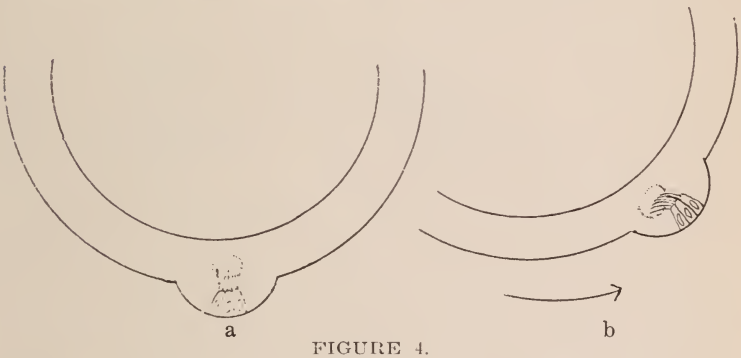


FIGURE 4.

Diagram of the Action of Inertia on Sensory Terminals of Ampullae; a, Canal and ampulla at rest; b, in rotation. In latter case the hairs of the sensory epithelium are dragged backward and irritated by the lagging behind of the endolymph.

so that in the canal corresponding to the plane of rotation there is a contrary current or pressure stress of lymph, which will produce torsion on the terminal plate and the cilia of the sensory epithelium projecting into the lumen from the ampulla, and, it is to be assumed, cause a specific

irritation of the nerve terminals. The axis of head-rotation will determine in which associated pair of canals this endolymph motion will occur. In motions which are not exactly in the axis of any pair of canals, there will be an associated action of several pairs. It is evident that the physical conditions for a contrary current due to inertia are satisfied only as long as there is an acceleration of rotation of a whole canal. After uniform rotation has been instituted there can be no relative motion or disturbance of balance between contents, endolymph and canal wall. Every positive or negative acceleration, however, and particularly a sudden cessation of rotation, must produce a marked displacement of the column of endolymph, which will continue to move in the direction of previous rotation (remnant of motion). The only serious objection to this hypothesis is the extremely small caliber of the canals, which in man are only 0.1 mm. square. This has been met by the substitution, for actual motion of the endolymph, which would probably be neutralized by friction against so narrow a wall, of a pressure state in the lymph such as might produce distortion in a vertical membrane hung up in its course. The crista projecting into the lumen of the canal would represent such a membrane. (Fig. 5.)

Breuer's theory of the static function of the labyrinth, as applied to sensations of position, is based on the assumption that the otolith mass on the macula is of so much greater density than the endolymph that various head positions must produce various degrees of pressure or stretching in the sensory hairs. With a macula in the horizontal position the macula would press directly on the hairs which carry it. In the reversed position, with the otolith plate below, there would be traction on the hairs. In any intermediate position of the system there must be distortion of the hairs which would reach a maximum, say, when the plane of the otolith plate and that of the macula were vertical in space. The obvious and striking difference of this mechanism from that of the ampullae and canals lies in a persistence of the mechanical conditions and of the torsional stimulus induced

by them, as long as the position of the system in space is unchanged, while the mechanical influence on the cupula in the ampulla takes place only when there is a change in the rate of motion of the labyrinthine contents. This duplicity of function, or rather of excitation modus, will serve to explain the distinction between those sensations and reflexes which are associated with motions, passive or active, of the head, and those which are due to permanent positions of the head in space.

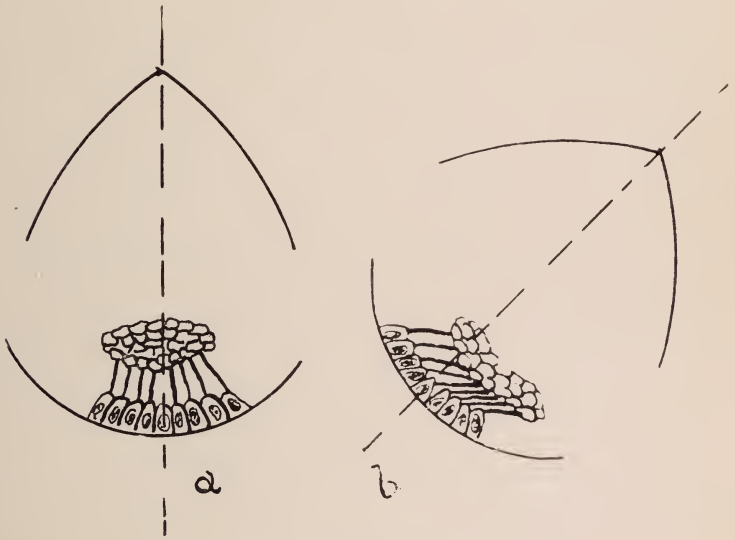


FIGURE 5.

Diagram of the Action of Gravitation on the Sensory Terminals of the Vestibular Organs (macule of sacculus and utriculus); a, vestibular organ at rest; b, inclined. In latter position the otolith plate drags on sensory hairs, distorting and irritating them..

Experiments on lower animals in regard to the function of the otoliths or otocysts, which can be removed without injury to other parts much more easily than the semicircular canals, show that they are essential for the maintenance of equilibrium. Crabs, squids, marine snails and other animals deprived of these organs, swim on one side or on the back or in circles. These experiments with defects are supple-

mented by one very instructive series of irritation tests. Certain crabs shed their sand otoliths at definite periods. Kreidl let crabs renew their otoliths with iron filings and then found that the approach of a magnet from one side was followed by a tilting of the animals to the opposite side, evidently for the purpose of restoring the balance which in sensation at least, had been disturbed by the displacement of the magnetic otolith.

The position of both horizontal (utriculus) and vertical (sacculus) otolith plate is quite logically explained to serve in erect and in supine position, respectively, the former in a state of functional equilibrium when the body is erect, the second, under stress, and vice versa.

Otoliths produce sensation of position, requiring steady and prolonged strain of gravity, and are not easily set in action by the usual degrees of motion-acceleration to which we are subjected. They would be useless if they reacted to every such impulse, as we should have subjective sensations of change of balance in every progressive motion. A forward jump would produce torsion of horizontal plate corresponding to falling backward. As a matter of fact such sensations occur only when rotational motions are combined with action of gravity, illusion as to real vertical inclination of body, and judgment of slant in surrounding objects corresponding to the resultant of gravitational and centrifugal factors.

There are certain positional reflexes in distinction to rotational reflexes, the most important of which are the compensatory positions of the eyes which occur when the head is tilted and which persist as long as this head position is maintained. A similar reaction is noted in birds and reptiles which keep the head in a certain position, in relation to the vertical, no matter how the body is pointed. These reflexes are explained by the function of the otoliths and their dependence on gravitation. As a certain deviation from the vertical is required before gravitation can produce torsion on the sensory hairs of the otoliths, we can now understand the function, mentioned above, of the retinal

meridians and of compensatory inclination in slight deviations. With an increased angle of tilt, the otoliths are affected and the change in head position becomes apparent to consciousness. Tests of tilting at various angles support this view. When tilted backward gradually, we underestimate the angle until 50° or so has been reached. From there on, there is an increase in the subjective sensation of tilting so that with a backward inclination of 75° we think we are in a horizontal position. From this point on the sensation of tilting increases rapidly, and when tilted so that the head points downward 15° we have the feeling of being inclined 45°, and think we are standing on our head when it is in reality only 30° below the horizontal.

THE EXPLANATION OF SENSORY PHENOMENA AND SOMATIC REACTIONS ON THE BASIS OF THE BREUER-MACH THEORY.

The Phenomena of Rotation.—At the beginning of a rotation motion, and with every change in its acceleration there is a definite sensation which is correctly interpreted, but this sensation disappears as soon as the rotation has become uniform (unless a change is produced by alteration of the position of the head). Retardation of the motion is interpreted by sensation as a motion in the opposite direction, and this is noted even after all motion has ceased. This subjective sensation of false motion, Mach's rotational vertigo, is explained by the motion-remnant in the endolymph, which is now active in an opposite direction to that caused while the system was in actual motion. The sudden sensation of motion coming on during uniform rotation, on turning the head actively through 90°, is also explained by a temporary acceleration imparted to the endolymph.

Reactions similar to those observed on passive rotation have been noted after irritation of a semicircular canal in which motion in the endolymph was produced by stroking or some similar mechanism (Ewald). There is invariably a turning of the head and a contrary motion of the eyes in the axis of the irritated canal (irritation test). Similar

reactions were noted in ear operations when a semicircular canal was exposed (Jansen). In doves, the head was turned to the sound side if the fluid was displaced toward the ampulla, and the irritation reaction was more marked than

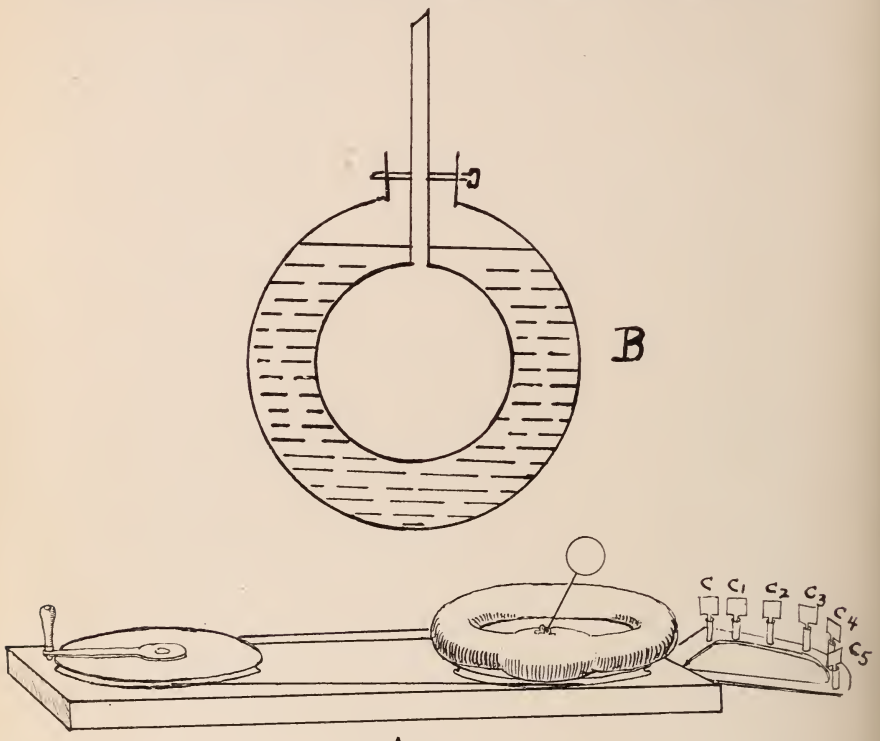


FIGURE 6.

Model showing Mechanical Principle of Function of Semicircular canals. A, turn table, with two revolving discs. On the right disc, a hollow ring of ¾-in. rubber tubing, not quite filled with glycerine and water, in which a small pendulum is suspended. B, detail of pendulum. Cross section through tube. To right, a quadrant, projecting beyond base, to demonstrate nystagmus. C-C5, pegs indicating external objects passing in rotation. On turning the disc, the fluid in the tube lags behind, at first, and holds back the pendulum, causing the indicator to tilt forward sharply in the direction of rotation. As the motion becomes more uniform, the indicator sends to stand upright. On stopping, the indicator reverses, sharply, showing action of momentum of fluid in tube, and physiological basis of sensation of reversed motion. Acceleration or retardation of rotation of disc is shown at once by motion of indicator in direction of turning.

when the fluid moved in the opposite direction, i. e., from the ampulla, when the head turning was toward the irritated side. We noted above that the ampullae are at opposite ends of each pair of canals. Bringing this into connection with the data gained by animal experiments we can understand that rotation to the right, for example, will produce a sensation of turning in this direction, the endolymph moving in the right horizontal canal from left to right toward the ampulla, as the occiput and with it the backward arched semicircular canals move from right to left. In the left semicircular canal the movement of the endolymph, in the same direction, i. e., from left to right, will be away from the ampulla and produce a minimum of irritation and, accordingly, of sensation. In left rotation we shall have a corresponding predominance of sensation in the left horizontal canal. If both sides are functionating normally there will be a correct interpretation of motion, and uniform somatic reaction on turning in either direction. If, on the other hand, there is an increased sensibility in one, this will be associated with intensified reaction. Again, destruction of function will allow the normally subordinate reaction from the other side, to which we have just referred, to become evident, and the weak sensation and reaction from the contralateral canal, produced by motion of endolymph away from the ampulla, will produce a positive reaction. As we shall see later, this has been made use of for a separate test of the labyrinthine function of the two sides.

DESCRIPTION OF NYSTAGMUS MODEL.

The quadrant is made of thin tin through which nails are driven at regular intervals to represent objects fixed during rotation. The nails are covered with thin rubber tubing to deaden the shock and noise, and a paper indicator stuck in the tube to show from a distance. A piece of rubber tubing is slipped over the pointer, too, to allow variation and adjustment of length, as in the "abducted" position, it does not project over the edge of the turn table as

far as in normal position, and so fails to strike the nails on the quadrant.

When properly adjusted, with pointer normal, each rotation alteration of the turn table produces a deflection of the pointer, which is caught and carried backward by the peg moving in the opposite direction. When the pointer has

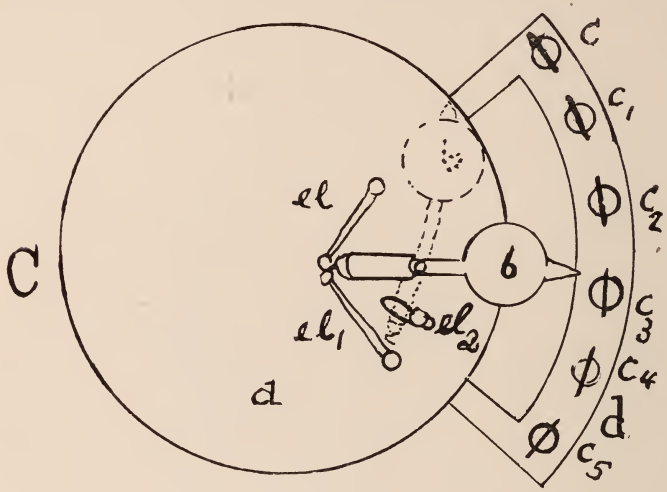


FIGURE 7.

Model showing Mechanism of Rotational Nystagmus. C, rotating disc; d, quadrant attached to base; C-C5, pegs representing external objects, in which, b, pointer representing visual axis, engages; el, el1, elastic bands, to bring eye back to position of equilibrium; el2, elastic band to bring eye into forced abduction, as shown at b with dotted line. In this position, the pointer has to be drawn out somewhat to make it reach the pegs in the quadrant. On rotation, representing motion of external objects while a person is turning, the pointer is caught and held for a moment by each object in turn, springing back with a rapid recovery motion to the normal position. On forced abduction with visual axis at a sharp angle with line of rotating objects, the pointer is held much longer, the nystagmus appears more marked when looking toward source of motion, and tends to disappear in opposite position.

been carried along for a space, it slips from the nail, or is released from fixation and jumps to the next object, or nail, with a rapid motion which is in the direction of actual rotation, i. e., toward the source of apparently or actually moving objects. This adjustment, or rapid correction leap,

the "Einstellung" of the Germans, is the more marked of the two motions in nystagmus, and it is according to the direction of this "rapid" clonic motion that the nystagmus is characterized as right, left, and so on. It has been shown that there is no clear vision during this rapid compensation or adjustment motion, and this may be seen quite clearly when we read lines of print. There is an adjustment after reaching the end of each line, the eyes jumping back in order to fix the first word at the beginning of the next line, far to the left. During this leap we do not see a single word clearly, and only one or two letters are picked up dimly. Rotation of the disc in either direction produces analogous results, i. e., nystagmus toward the direction of rotation. The effect of abduction, as by active fixation to one side, during rotation, can also be demonstrated on this model. If we attach a third elastic band (el2) to the pointer so that it no longer points out radially from the center of the turn table, but, as shown by the dotted lines, is inclined toward one end of the line of nails on the quadrant, we find that the catching and release of the pointer, which as explained above corresponds to fixation-tonus and compensation-leap, are very slight when the pointer represents an eye looking backward, i. e., away from the direction of rotation, and very marked when the eye looks forward in the direction of turning. This is not only in harmony with the observations of every day life and clinical study, but can be very simply explained mechanically and visually. On looking backward away from the source of motion there is less apparent motion; the object moves through a smaller arc in the given time. If we look directly backward, for instance, there will be practically no motion, the object merely becoming "small by degrees and beautifully less." On looking forward in rotation the objects come into the field of vision sooner and are in the field of fixation longer; there is a corresponding sense of greater motion and a greater actual leap of compensation or clonic fixation greater evident nystagmus. Mechanically we must remember that in looking forward in right rotation for instance, we conscious-

ly innervate the muscles for right abduction, so that this volitional stimulus would be added to the unconscious or automatic adjustment of fixation, produced by motion of external objects, which, as we have seen, also corresponds to abduction in the direction of rotation. In looking away from the rotation to the left, we innervate an opposite set of muscles consciously, to those which are being set in action automatically, and the two impulses are not summated as before, but tend to neutralize each other. Clinically it has been noted that nystagmus is increased on looking toward the diseased side, i. e., in the direction of apparent rotation, and that it may be apparent only in forced abduction to this side. Conversely, nystagmus may be inhibited by looking toward the sound side. This abduction also tends to inhibit or entirely prevent vertigo, and is made use of for this purpose by ballet dancers and skaters to prevent dizziness in whirling. The head and eyes are turned backward, away from the direction as far as possible, and forced fixation in opposite abduction used to keep the eyes in line with one point, usually the center of the auditorium. In this way the motion of the head and eyes is artificially slowed and reduced to a minimum. After the body has moved through a large arc and made almost a complete revolution, the head is, actively, turned to catch up with it, and fixation to one side again takes place. In this way we have an interrupted motion of the head and eyes, giving the semicircular canals a chance to come to rest frequently and producing a small repeated reaction with which the sense of balance can cope without sensation of dizziness, in preference to allowing an accumulation of irritation through prolonged endolymph rotation, which on cessation of whirling, might produce extreme giddiness and loss of balance.

TESTS OF THE STATIC FUNCTION.

It has already been stated that the adequate stimulus for the ampullary organs is the motion of the endolymph produced by rotation. As in other sensory organs, a number

of other stimuli can be made to replace the normal and physiological irritation. Thus, condensation or rarefaction of air in the external auditory canal, especially when the external horizontal canal is exposed, will produce a change in the intracanalicular lymph stress. Even concentrated light under these conditions, will act as an irritant (Lucae). Mechanical pressure by a probe or by granulations, on the oval window will act similarily, and thermic irritation by hot and cold water or galvanic currents, will supply sufficient stimuli. In all these cases we have definite sensations of rotation motion, and definite somatic reactions of eyes and head. The manifold and somewhat complicated phenomena may be most simply summed up as follows. Each irritation of a semicircular canal corresponds to a sensation of motion which is interpreted as taking place in the direction of the endolymph stream, i. e., as a rotation toward the irritated side. The somatic reaction consists in an attempt to fix objects in motion coming from the irritated side, as they naturally would if there were actual motion. There will be a rapid turning of eyes to the irritated side, "Einstellung," with a slower fixation tonus in the direction of the moving objects, i. e., nystagmus to the irritated side. The head will turn against the fancied motion in an attempt to correct the subjective sensation of displacement, and the trunk muscles on the irritated side will receive a stronger innervation or an increased tonus for the same purpose, i. e., to correct fancied motion change or compensate for apparent alteration of balance. We shall now consider the various methods of stimulating the ampullar apparatus and note the underlying principle which will explain the uniformity of reaction.

Dizziness and quite possibly nystagmus (although this has not been studied) may be caused by irritation of semicircular canals by molecular vibration of endolymph due to sound waves. The tone vibration must be of unusual amplitude to cause this phenomenon, and accordingly we note unpleasant subjective sensation of dizziness with unusually low and strong notes, as the deep contra-bass of an organ, a low pitched fog horn or the hum of a locomotive exhaust.

Physiologists have not decided whether the disturbances of equilibrium noted after destruction of the labyrinth are due to this destruction directly, say by irritation of the nerve trunk, or whether these disturbances are the expression of a predominance of the contralateral sound labyrinth and a consequent alteration of the balance of sensory perceptions in the static central apparatus situated in the cerebellum. In other words, whether we have to deal primarily with phenomena of irritation or of paralysis, loss of function. Clinically this is not of practical importance as in labyrinthine disease we have almost always an extended period of irritation due to inflammation or hemorrhage. In patients we shall have to distinguish a stage of irritation and a stage of function loss which is secondary, i. e., develops later. A sharp differentiation is not always possible as loss of function may begin while irritation persists, just as in affections of the cochlear branch there may be loss of hearing with subjective tinnitus.

The main symptoms of irritation are nystagmus, disturbance of equilibrium and vertigo, with nausea and vomiting. Boenninghaus claims that the first three symptoms are related, inasmuch as nystagmus causes vertigo or false sense of rotation, and that this in turn produces loss of equilibrium. Nystagmus, involuntary eye motion, produces a sensation of objective motion when the eyes are open or of subjective motion when they are closed; pseudo-rotation or vertigo as opposed to vertigo or dizziness in the wider sense such as visual vertigo, and so forth. The dependence of rotational vertigo on nystagmus has been demonstrated by Barany who showed that vertigo does not occur if the nystagmus is suppressed, e. g., after rotation with closed eyes, if the gaze is directed away from the direction of rotation. The direction of apparent rotation is in the direction of nystagmus, but the body, to compensate for the supposed displacement, deviates in the opposite direction. This involuntary compensatory reaction disturbs the balance of the body and leads to swaying, reeling, stumbling or falling to one side or the other.

Function loss symptoms consist in disturbances of balance without vertigo, and nystagmus without nausea and vomiting. They are not markedly different from the analogous irritative symptoms except that the latter are more marked, varied and irregular in intensity, in accordance with the varying degree of irritation.

In tests of the static function, nystagmus and balance disturbance offer objective evidence and are therefore more valuable than the subjective sensation of vertigo, which furthermore may be complicated with disturbances of general consciousness or indeterminate psychical reactions. Nystagmus is particularly valuable as a symptom (Barany) because it is absolutely independent of physical control.

CLINICAL TESTS FOR NYSTAGMUS.

Labyrinthine Nystagmus.—Irritation of a single semicircular canal in animals causes a definite motion of the eyes. If the irritation continues, a clonic spasm takes the place of the single muscular contraction. After destruction of the labyrinth there is neither nystagmus nor vertigo on rotation. A similar condition is noted in deaf-mutes with loss of both labyrinths. This form of nystagmus can be distinguished from nystagmus due to amblyopia. The latter is even, tremor-like, the former irregular, clonic, like the twitching motion seen in paresis of the external rectus muscle when an attempt is made to fix in abduction. In the usual erect position with the head held vertically, there is a horizontal or circular motion of both eyes to the right or left. The two motions are not equally rapid, and the direction of the rapid motion determines the characterization of the nystagmus, as nystagmus to the right, left and so on. The nystagmus is increased by looking in the "rapid direction." This can be explained mechanically by the fact that voluntary innervation now assists the subconscious innervation action of the muscles turning the eye in the direction of the gaze which is identical with the direction of the nystagmus. It is also possible that a greater arc of motion is offered for the compensatory effort as well as for the steady

fixation component and that the sensation of external motion is more extended when the eyes are turned toward the source of apparently moving objects. This is undoubtedly the case in the reflex nystagmus which occurs when we fix objects from a moving train or a caroussel. The apparent motion of these objects and the visible nystagmus are both much less marked when we look back along the line and away from the direction of turning. Labyrinthine nystagmus may be so slight as to appear only in forced abduction in the "rapid" direction, i. e., toward the irritated side. The excursions may be large or small, rapid or slow. At times they can be seen only with good illumination or with a magnifying glass, on close inspection while the patient fixes an object held far to one side. Labyrinthine nystagmus may be elicited by a number of stimuli or it may be spontaneous. It is then a symptom of labyrinthine irritation, and is accordingly directed toward the diseased side. It may be assisted by holding the head low and thus causing labyrinthine hyperemia. In labyrinthine irritation, nystagmus may be caused by simple turning of the head, which is quite unusual in health.

NYSTAGMUS AFTER BODY TURNING. (ROTATIONAL NYSTAGMUS.)

Active or passive rotation of the body about its longitudinal axis causes nystagmus in the direction of turning (Purkinje, 1825). Sudden cessation of rotatory motion is followed by reversal of the direction of the nystagmus, after-nystagmus. In labyrinthine irritation, rotation toward the diseased side may produce nystagmus after only one or two turns which also lasts longer than nystagmus following rotation in the opposite direction. The semicircular canal around which we turn is always irritated most actively, as under these conditions the motion of endolymph is toward the terminal nerves in the ampulla. Unilateral loss of labryinthine function does not produce any lasting alteration of the nystagmus, but it disappears entirely.

Barany has also noted that when there is a fistula in the bony wall of the labyrinth, compression or rarefaction of the air in the external meatus will produce typical labyrinthine nystagmus and vertigo. The details of this reaction have not yet been worked out.

When both labyrinths have been destroyed, as in deaf-mutes, if only one semicircular canal is destroyed, nystagmus will, for a time, be more to the sound side. Practically there are technical difficulties in the way of accurate observation of rotational nystagmus. It has been suggested that the observer seat himself on the turn table with the patient and palpate the latter's closed eyes with the finger tips to determine the character and direction of the nystagmus. Practically it is more simple to test the after-nystagmus which takes place on cessation of rotation. In normal individuals about ten rotations are needed to produce decided nystagmus, while in labyrinthine irritation two or three turns suffice. The subjective sensation of rotational vertigo and the disturbance of equilibrium associated with it can best be tested by having the patient get up and try to walk in a straight line after rotation has ceased.

Caloric Nystagmus.—The specific action of heat and cold was discovered in animals by Baginski in 1881, and studied and applied to human beings by Barany, 1906, who first recognized its physiological and diagnostic significance. If the ear be irrigated with water above or below the body temperature, nystagmus is produced which is more marked as the temperature contrast increases, and ceases when water of an indifferent temperature is used. Hot water acts as an irritant, i. e., as a stimulus corresponding to rotation to the tested side, while cold water acts as a depressant, with a diminution of sensation of rotation toward the tested side, or what amounts to the same thing if the body is at rest, to a motion toward the non-tested side. Accordingly hot water nystagmus is directed to the tested side, cold water nystagmus to the non-tested side. After destruction of the labyrinth there is a loss of caloric reaction. This has been proven by tests on animals (Kubo, 1906), and

observations on patients with known destruction of the labyrinth. Barany lays great stress on this point, and claims that we have in the caloric method an accurate means of determining the presence or absence of function in either labyrinth. A negative finding would mean that any objective reaction, such as spontaneous nystagmus, must be due to the labyrinth of the opposite side or to non-labyrinthine factors, such as involvment of the cerebellum, and the same author claims that the diagnosis of cerebellar abscess can be facilitated by means of this procedure. The mechanic explanation of caloric nystagmus is found (Fig. 8) in the production of currents in the semicircular canal due to the change in density of the endolymph which follows the change in temperature. Barany says: "Imagine a closed vessel filled with water at 37° C. to represent the labyrinth. Syringe one side of this cup with cold water. The water nearest this side will be cooled and thereby get a greater specific weight, tending to move toward the bottom of the cup, while on the opposite side the warm water rises. In the same way and for the same reason a movement of the endolymph is produced in the semicircular canal."

The diagram (Fig. 8) also explains sensory and motor reactions to rotation. a + shows effect of positive irritation of R. ampulla, by rotation to right, accompanied by homonymous nystagmus (R) and compensatory head turning (L). The canal rotates from left to right, producing a stress toward the ampulla (serpentine arrow at B.), and sensation of motion to R. b — shows negative or reversed stimulation, of ampulla, immediately after cessation of rotation, producing reverse stress in endolymph, sensation of reversed motion, and movement of objects to opposite side. Accompanied by after-nystagmus, heteronymous (L.) corresponding to sensation of subjective and objective motion. Compensatory head turning and body motion, as before, opposed to direction of nystagmus, are (R.) to restore balance, supposedly disturbed by rotation to left. This after-nystagmus and after-vertigo are easily observed after a few rotations when the subject attempts to stand

and walk straight forward. It is also frequently seen in every day life, after whirling in dancing or skating. The dizziness does not come on until the rotation has ceased,

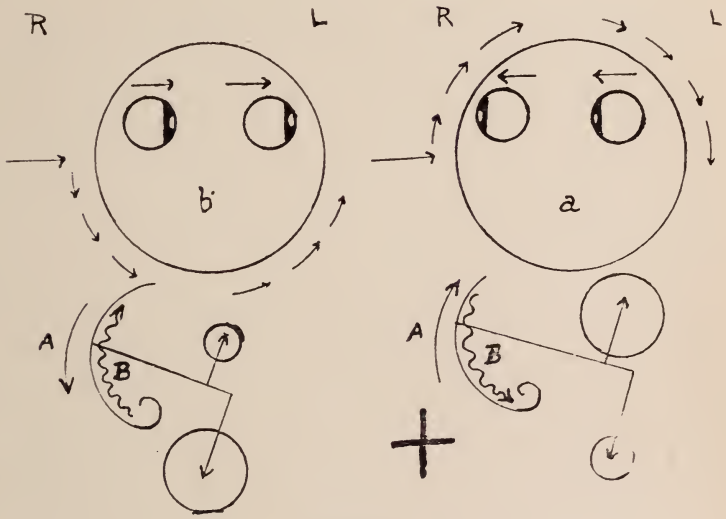


FIGURE 8.

Diagram showing Direction of Nystagmus, Head Turning, and Subjective Sensation of Motion, caused by Caloric, Mechanical, or Galvanic Stimulation; a b, face seen from in front, indicating direction in which eyes are turned and nystagmus takes place; a, positive stimulation; x, as by syringing right ear with hot water, turning patient to right, compressing air in right meatus, or closing galvanic current with anode on right ear. Nystagmus, toward R (small circle with arrow), head turning to opposite side; L (large circle with arrow), movement of endolymph (serpentine arrow at B), strong, toward ampulla, away from source of irritation, or direction of rotation, toward opposite side; L, giving subjective sensation (long arrow at A) of rotation toward irritated side; R § b, negative; —, stimulation as by cold water syringing of right ear, rotation to left, rarefaction of air in right meatus, cathode closure on right ear.

but then takes place immediately, and the subject reels in the direction of previous rotation, after coming to a stand still, as if by some inward momentum. In fact, it is due to an attempt to correct the supposed disturbance of equilibrium or position. The vertigo may be inhibited, partially or wholly, by forced fixation away from the direc-

tion of motion, real or apparent. b—also shows the effect on the R. ampulla of turning to L during passive or active rotation. The endolymph motion (serpentine arrow) is away from the R. ampulla, hence weak, and may be described as producing a weak sensation of turning away from the right, and corresponding in every particular excepting intensity to the sensation reactions on right rotation in the left external ampulla. It is conceivable that after loss of function in the left labyrinth, this ordinarily subordinate sensation might be sufficient to cause an independent reaction and gradually compensate, in part for the lost function of the contralateral labyrinth.

Nystagmus might be viewed as part of the somatic reaction having for its object the establishment of an optimum position of the eyes, corresponding with macular fixation of an external object coming into the field of vision from the source of apparent motion, or with corresponding subjective change of position; in other words, an equalization of visual stimuli, and as an aid to balance to be gained from vision by fastening on, and as it were being supported by a sense impression based on objective data. The nystagmus observed in disease and in experiments must be considered as running in habitual channels. The purposive element, of course, no longer appears, but that element can be detected and is logically to be explained. Thus there is no actual attempt at fixation in labyrinthine disease or rotational nystagmus, as is shown by persistence of this ocular motion when the eyes are closed or exclusion glasses worn, but the memory of this tendency, the local sign and tradition of this intuitive reaction persists and comes out, non-purposively as a symptom.

TECHNIC OF CALORIC TEST.

To produce an even stream of long duration and what is important in labyrinthine suppuration, as little mechanical irritation through pressure of the stream as possible, it is

not advisable to use a syringe. A large Politzer bag (Boenninghaus) or a fountain syringe hung a little higher than the ear may be used. A fine ear irrigating tip or an elastic middle ear catheter, introduced through an aural speculum is then carried close to the drum, an assistant managing the Politzer bag while the surgeon observes the eye-motions. These generally appear in from three-fourths to one and three-fourths minutes with intact drum, but in case of perforation they may be seen with good illumination in a few seconds, and last for several minutes. Cold water, at a temperature of about 50° to 60°, i. e., 40° lower than body temperature, is best for practical reasons as a like contrast could not safely be produced with warm water as the temperature would have to be over 130°.

Galvanic Nystagmus.—Breuer showed (1888, 1903) that on galvanic irritation of the exposed semicircular canal of the dove, head and eye movements took place, and that this reaction could be prevented by cocainization of the corresponding ampulla. After bilateral destruction of the labyrinth there is no reaction to galvanism. Similar conditions were noted in deaf mutes with total absence of labyrinth (Pollak, 1893). These observations exclude the possibility of cerebellar involvement in the galvanic reaction. The cathode acts like hot water, i. e., as an irritation corresponding to rotation toward the tested side. The nystagmus, as before, is toward the same side, and head motion to the opposite side. This appears to show that the galvanic current, running as it does from cathode, negative pole, to anode, positive pole, acts on the ampullar nerve terminals exactly as an endolymph current would when moving in the same direction, so that, translated into terms of subjective sensation, the passing of a current through, say the right horizontal canal from right to left would be felt as an endolymph motion would, i. e., as a turning motion to the right or irritated side. The anode causes the opposite reaction and is analogous to that of cold water, nystagmus to the "sound" side, and head turning to the side of

irritation. Barany places the anode on the ear to be tested, and the cathode in the opposite hand. This is preferable to the transverse current through the head, as it allows either labyrinth to be tested separately. Nystagmus occurs more easily when the gaze is directed toward the cathode, i. e., again toward the source of apparent motion and of actual irritation, and toward the direction of subjective rotation. It can be elicited by currents of 2-6 milliamperes; while with the gaze in the opposite direction, 10-15 are usually required. Barany has noted that in labyrinthine destruction it is impossible to elicit galvanic reaction from the destroyed side, a complete analogy with caloric nystagmus. Babinski (1901) attached more importance to the compensatory head turning, which he found always took place toward the diseased side, when this side was stimulated either from cathode or anode. This "ear phenomenon" of Baginski is only found in unilateral disease of the static apparatus, according to Mann (1907); a significant observation requiring further study. Deaf mutes without rotational vertigo also show a loss of the galvanic reaction (Pollak, 1893).

GENERAL CONSIDERATIONS IN REGARD TO TESTS.

This general review of the history of investigation and the sketch of our present knowledge of the structure and functions of the inner ear must be supplemented, if it is to be applied to the practical needs of clinical otology, by a study of the functional reactions in health and disease. It is evident that even the most minute and elaborate tests of patients presenting symptoms of labyrinthine involvement can result in accurate knowledge of the underlying morbid conditions and lead to a definite diagnosis only if we have a fairly constant and definite basis of normal reactions from which to measure given variations. It may be said here, by way of parenthesis, that there still remains a great deal to be done in this field. A large number of carefully conducted tests on normal individuals is needed to show the reactions to rotation, caloric, galvanic, and

postural irritation, the physiological limits of balance, the determining factors of vertigo, and so on. Even then the subjective quality of many of the reactions, for instance vertigo, dizziness, loss of equilibrium, will tend to vitiate accurate conclusions by the interjection of the personal equation of both patient and observer. The elaboration of quantitative tests will of course be the ideal in this direction, and the reduction of all observations to a uniform basis will simplify the entire subject. As to the application of these tests in disease, there are of course, other points, pro and con, to be considered. Many of the tests, such as those of rotation vertigo and of balance angle, require special apparatus, a trained observer, much time, and more patience, besides the good will and co-operation of the subject. It is more than doubtful whether the tiresome and occasionally disagreeable rotation tests could be applied in private practice or even to any great number of clinic patients. The possibility of aggravating symptoms already present or of fancied injury on the part of the patient must be borne in mind. Galvanic irritation should be applied with the smallest perceptible current strengths, caloric nystagmus should be elicited without any mechanical violence, and the possibility of sudden falling should be thought of at all times, not only for the reasons just mentioned, but because, as we shall see, all these methods produce reactions in normal individuals and the results of our tests would be anything but instructive if they were conducted so hastily and roughly as to produce results which could be due to widespread irritation or the coincident reaction of distant sensory or central organs. This will be considered more in detail in the description of the clinical examination and tests of the labyrinthine functions.

THE REACTION OF THE NORMAL LABYRINTH TO FUNCTIONAL STIMULI AND EXPERIMENTAL IRRITATION.

Barany's tests were on normal subjects, patients with cranial injury, and on twenty-four cases of labyrinthine

unilateral destruction. Up to the 50th year, age has no influence on the duration of consecutive nystagmus after prolonged rotation (10 turns). In normal subjects the average duration is 40 seconds, but there are marked individual variations. In dancers who do not "reverse," and are accustomed to dancing only to the right, the nystagmus is decidedly less marked after rotation to the right. Those who dance equally well to the right and left react like normal subjects. In health as well as disease after-nystagmus is more marked and lasting after rotation to the left. Repeated rotation tests show no signs of exhaustion in the reaction to turning; active fixation while turning tends to inhibit nystagmus. It is, accordingly, more marked if dark glasses are worn during the test, and lasts two or three times as long. Increased rapidity of turning lengthens the period of nystagmus and causes larger and more frequent excursions. The number of rotations up to 10 increases the duration of after-nystagmus, but with continued rotation (Barany has gone as high as 60), the latter again becomes less. After 20 or more rotations the after-nystagmus is followed by reversal (tertiary nystagmus) in the original direction of rotation, which is of central origin.* In many normal persons one or two turns are sufficient to cause after-nystagmus, if fixation-correction has been excluded by dark glasses. In case of destruction of the labyrinth of one side the nystagmus is always more marked and lasting toward the sound side. Smokers and neurasthenic subjects show increased irritability to rotation stimuli.

Ocular torsion or wheel motion of the eyes, first noted by John Hunter in 1786, which compensates for head tilting and persists until the vertical position is again assumed, must also be considered as a labyrinthine reflex for all but small angles of inclination, as noted previously. After

*This "tertiary" nystagmus appears in the model as a gradual advance of the pointer to the vertical, from reverse position (secondary nystagmus) as the fluid comes to complete rest after rotation. It can be explained quite as simply as primary nystagmus by the local conditions in the semi-circular canals, without recourse to the central organs for a basis of explanation.

destruction of both labyrinths in animals, this torsion does not take place, while it is markedly diminished, according to Barany, in deaf mutes and bilateral destruction of the labyrinth in normal beings. In unilateral destruction there is no alteration, but in unilateral irritation there is decided increase of compensatory ocular torsion. In normal subjects a tilting of the head of 60° corresponds to ocular torsion of 4° to 16°.

TESTS OF EQUILIBRIUM.—V. STEIN, 1895.

v. Stein distinguishes between static and dynamic tests, in accordance with the theory of Breuer and Mach. For the former he uses a movable inclined plane on which the patient stands. The angle of inclination is then increased until balance can no longer be preserved. Tests with this goniometer show that in the upright position normal subjects can be tilted backward 36 to 39°, forward 26 to 30°, and tipped sideways 36 to 38° before they fall. When the eyes are closed the angle of fall is 3 to 4° less.

Dynamic tests note the variations from a straight line or the tendency to fall in a certain direction when moving in various ways. The difficulty of preservation of balance and direction increases as we proceed from standing to walking and hopping, from the flat foot position to tip toe, from a support on both legs to a single point d'appui. The difficulties are still further increased by closing the eyes and by moving backward. By these progressive tests v. Stein and others believe it possible to detect slight disturbances of equilibrium which would otherwise escape observation, especially when the patients themselves are not conscious of them.

Normal subjects can stand with closed or open eyes, on both feet, for many minutes without marked swaying. Walking backward and forward, under like conditions, generally follows a straight line. In labyrinthine affections Romberg's phenomenon of swaying, and characteristic deviations from the straight line are frequently noted. The

more difficult tests are not equally well passed by normal individuals. Practice and special skill account for the various reactions, and as Boenninghaus has observed, we may be in doubt in a particular case what we are to ascribe to

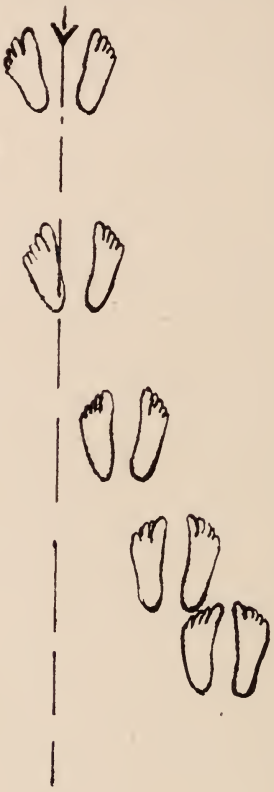


FIGURE 9.

"Labyrinth Hops," v. Stein, on hopping backwards. Disease of right labyrinth.

individuality and what to disease Yet we may assume that in simple clumsiness or lack of practice, the defect of static and dynamic balance will be the same on both sides, while in labyrinthine affections there is usually marked inequality. The following phenomena have been found char-

acteristic, but not invariably present, in labyrinthine disease:

1. The affected side is the weaker. In standing or sitting the body inclines or falls to the diseased side. In walking or hopping there is a deviation to the diseased side, the patient does not stand securely on the leg of the diseased side, and the body can be more easily pushed over to the diseased side by the observer (Adler, 1894; Hinsberg, 1901; Krotoschiner, 1906).

2. The body muscles tire rapidly, so that in hopping, the jumps become shorter and shorter, until finally they "mark time," and are made on one spot (labyrinth jumps of v. Stein). (Fig. 9.)

3. Falling can be prevented by merely giving the patient a finger (Mann, 1907), as the slightest tactile sensations will compensate for the labyrinthine defect.

4. Falling is sudden, unexpected, and complete. The patient falls "like a log," without regard for possible injury and without the power of prevention or compensation, so that the necessary precautions should always be taken by those who institute these tests.

Finally it may be noted that tests with the dynamometer, the ergograph, and other instruments of precision show a decrease of muscular energy, tone, and muscle sense, and characteristic curves of muscular action, in labyrinthine disease corresponding closely to the results of animal experimentation.

NON-ACOUSTIC SYMPTOMS OF LABYRINTHINE DISEASE.

According to Barany, the diseases of the semicircular canals may be divided into three groups:

1. **Circumscribed labyrinthitis.** O. I. circumscript.—Symptoms due to irritation by hyperemia or toxic edema. Spontaneous nystagmus at intervals, elicited by head motion toward diseased side. Caloric test positive. Many diseases show this reaction. The most important are circumscribed labyrinthine suppuration, and fistula. Fistula symptom

(nystagmus on air compression) may be elicited. Subjective sensations usually present. Marked vertigo, nausea, and occasionally vomiting. Partial deafness. **Rotation** toward diseased side increases spontaneous nystagmus, or brings it on after one or two turns. After-nystagmus to sound side slight. **Vertigo** present. **Disturbance of equilibrium.** Head turns away from diseased side, and with head upright, patient falls away from diseased side (Attempted compensation.) If head is turned toward diseased side, patient falls backward, and vice versa. **Tonus** increased on diseased side. **Rotation** toward diseased side causes more marked and lasting somatic reaction, which may occur after one or two turns. **Recovery** with normally irritable static apparatus.

2. **Diffuse labyrinthitis.** O. I. P. A.—Loss of function due to acute and widespread suppuration, and indicated by the loss of caloric reaction. Total deafness. Spontaneous nystagmus to sound side, due to complete loss of function on diseased side and comparative excitation of remaining normal labyrinth is continuous, present in all positions, and tends to disappear. Tinnitus and spontaneous nystagmus occasionally persist for some time. Rotation toward diseased side causes slight somatic reaction, if any. Vertigo may be absent. Facial parlysis frequent. **Disturbance of equilibrium.** Tendency to fall or walk toward diseased side. Gradually corrected and compensated for by tactile and visual sense. **Tonus** markedly increased on diseased side. **Recovery** with unilateral loss of static function and loss of reaction to rotation.

3. **Chronic diffuse labyrinthitis.** O. I. P. C.—Loss of function due to old suppuration. Spontaneous nystagmus to sound side no longer present. Cerebral compensation and adjustment of temporarily disordered balance of labyrinthine stimuli. Caloric nystagmus absent. This may occur in cases which have progressed slowly from the start, with a sub-chronic course, nystagmus and vertigo never having been noted, and in cases of long standing labyrinthine suppuration with widespread destruction. Fistula symptom absent.

Rotation. In 2 and 3 there is marked after-nystagmus to sound side. **Vertigo** absent. **Disturbance of equilibrium** shows gradual compensation. **Tonus** gradually restored, but muscular weakness remains.

SENSE OF BALANCE.

The sense of equilibrium and power of balance in human beings is a variable factor. Probably not congenital, as shown by the unstable equilibrium of small children, even when muscular power is great, and by the slight tendency to vertigo, which is rarely noted before the eighth year. Children are not subject to sea-sickness, can swing without becoming dizzy, or whirl in dancing or at play much more freely than adults. There are probably differences in the two sexes and at different ages. Neurasthenic or hysterical individuals are particularly susceptible to vertigo and nausea. Occupation and training are of importance and in tests of patients with labyrinthine disturbance it is well to ascertain what movements could formerly be performed correctly. There is a tendency for normal individuals to circle to the right in walking, and turning to the right especially in dancing is comparatively easy for the right-handed. Reversing is difficult for many, and this faculty should be inquired into. The tactile sense, muscle sense, tonus and sensations in the viscera combine to form one large uniform source of sensations as to our position in space. Visual sensations, sensu strictiori, and sensations of ocular muscle innervation, form a second. The third, labyrinthine sensations or disturbances, are generally subconscious and for that reason externalized and interpreted by the sensorium as sensations of objective or subjective motion. Normally, all changes of position or of equilibrium are associated with a sense of change in the field of vision, of the position of external objects as to us, an external disequilibration as opposed to the internal. Vertigo is produced when there is contrary innervation or discrepancy between the two sensation states. Thus even rapid and irregular motion of

objects in the visual field will of themselves not cause vertigo, whereas very slight displacements will suffice when there is an absence of the usual corresponding sensations in the ocular muscles or those of the body.

OBJECTIONS TO BREUER-MACH THEORY AND V. STEIN'S TESTS.

Objections to conclusion from animal experiment, particularly section of the semicircular canals, as well as to deductions from the phenomena of their disease, in so far as it was assumed that these symptoms were evidence of local changes, were made from the beginning of investigations in this field. It was repeatedly claimed that the results were vitiated and the facts obscured by complicating disease or accidental injury of contiguous cerebral structures. Thus Hitzig (1871) believed that the phenomena of galvanic irritation nystagmus were due solely to cerebral irritation. Disproved by cocainization of the ampulla, and by observations on deaf-mutes. Boettcher (1875) laid stress on possible injury by traction on the nerve trunks in semicircular canal experiments. Weber Liel (1880) considered brain irritation through changes of pressure in the aquaeductus cochleae sufficient explanation. v. Bergmann, in the same year, attributed Ménière's complex in the case of a fissure through the labyrinth to coincident traumatism of the brain. Lucae and Baginsky, judging from the effects of the air-douche and of injection of fluids into the middle ear, claimed that transmission of external pressure to the cerebrospinal fluid and consecutive central irritation or injury was the principal factor in disturbance of equilibrium. Baginsky in fact claimed that Ménière's complex was invariably dependent on cerebral lesions. Steiner (1888) claimed that all observed disturbances of motility could be explained by traction on the trunk of the auditory nerve, and that the phenomena were forced movements, not balance-compensations. Other investigators claimed that the varied data of animal experimentation were due to faulty observation, and

that with careful section of the semicircular canals there are no disturbances of equilibrium whatever. (Boettcher, Lussana, 1872). There may be extensive disease of the labyrinth without a trace of disturbance of equilibrium (Lucae, 1882). Kiesselbach and Steiner experimenting on fishes and lizards, were unable to find any disturbances after injuring the semicircular canals. J. D. Richards (Treatment of Purulent Affection of the Labyrinth, Annals of Otology, etc., Sept., 1907) claims that sound waves affect the non-acoustic as well as the acoustic labyrinth, and gives as a practical example, a case in which after exenteration of the entire labyrinth, loud musical sounds produced intense dizziness. This merely proves again what was well known, that the central trunk of the eighth nerve transmits acoustic as well as equilibrational stimuli, giving rise to cerebellar sensory reactions, and does not in any way invalidate the theory of the non-acoustic function of the labyrinth. Other objections raised by Richards on the basis of a case in which disturbed equilibrium, vertigo, vomiting and nystagmus were relieved by removal of semicircular canals, vestibule, and lower half of the first cochlear whorl, are due to his having confounded evidence of irritation with loss of function. The removal of a source of irritation and of false localization would naturally be followed by disappearance of double or faulty sensation. Richards recurs to the old theory of concomitant injury of central organs or of centripetal nerves which he resurrects under the name of "peripheral irritation," to which the interior of the labyrinth is supposed to be subjected in removal of parts of the labyrinth. His deduction that nystagmus and other reactions are not entirely due to the loss of parts of the labyrinth, because under anesthesia mechanical irritation of the interior of the vestibule or on the ampullary areas may produce nystagmus, is faulty, inasmuch as anesthesia does not in any way exclude the function of the organ of equilibration. Against the practical application of v. Stein's tests, Richards states they are subject to numerous

errors, as, irregularity in length of limb, a badly arched foot, fear of falling, and claims that a patient if he be right-sided (handed) attempting to jump in a straight line, will deviate to the left and eventually tend so to fall if the eyes are closed. In the hopping test, the patient is not in contact with the floor long enough to gain a correct subjective appreciation through muscle sense of his proper relation to the objects about him. The disconcerting of muscular sense and suppression of orientation inherent in v. Stein's tests, create inequilibrium, so that if disturbed balance appears during the test we are at a loss to know what factor is responsible; in other words, it is not a differentiating test. In answer to these objections it can merely be said that they are not borne out by the results of practical experience. Normal individuals, whether flat footed, right or left handed, or otherwise asymmetrical, do preserve normal balance and walk straight forward or backward without difficulty, whereas, as shown by numerous observers, and again recently by Eagleton, labyrinthine disease does produce characteristic disturbances. No disequilibration is produced by v. Stein's test except the pathognomonic disturbance which we aim to elicit, and as to the tactile sensation during hops, if the length of time between them were insufficient for orientation, we should all lose our balance when hopping, and there would be no tendency to fall to one side in preference to another. Richards' objections to theory and practice of equilibration and nystagmus tests are not well founded.

Discussion.

Dr. B. Alex. Randall, Philadelphia:—I have long used a ridiculously simple demonstration of this function of the semicircular canals; I have found that it made the matter of the connection of the ampulla and cristae as acted upon by the endo-lymph plain to students when we demonstrate the inertia of water in a glass in which a match is floating.

The glass can be rotated on its vertical axis back and forth with no motion of the match, except the after-motion due to friction at the periphery. Of course, Dr. Friedenberg's demonstration so far excells this that it is not to be mentioned in the same breath, but is a ready way of showing the mechanism.

Dr. George E. Shambaugh, Chciago:—It is not many years since physiologists looked upon the labyrinth as having only an acoustic function. It is very interesting to see how they distributed an acoustic function over the several organs found in the internal ear. In the first place a distinction was made between tones and noises. The tones were supposed to be taken up by the end organs in the cochlea, that is the organ of Corti, while the noises were supposed to be taken up by the end organs in the vestibule, viz., the macula acoustica of the utricle and the saccule. The position of the three semicircular canals, occupying the three planes in space, lead them to attribute to these canals the function of determining the direction from which sounds come. We now attribute to the end organ in the cochlea the whole function of sound perception. Our nomenclature of the end organs in the vestibule and the ampullae still retains the idea of an acoustic function. We have in the vestibule for example the macula acoustica and in the ampullae the crista acoustica.

THE EPITHELIUM OF THE SULCUS EXTERNUS.

By GEO. E. SHAMBAUGH, M. D., of Chicago, Ill.

The term sulcus spiralis extermus is applied to that part of the outer wall of the scala media lying between the promentia spiralis above and the crista of the ligamentum spiralae below. The epithelium covering the promentia is composed of a single layer of low cuboidal cells. The epithelium covering the crista of the spiral ligament consists of the tall cylindrical cells of Claudius. There lies in the bottom of the sulcus externus a clump of epithelium continuous with the layer of cells covering the spiral prominence and covered over in part oftimes by the cells of Claudius. It has long been known that this epithelium occassionally sends long processes off into the underlying spiral ligament. These processes have been construed by some to be nutrient processes. By others they were supposed to have a contractile property capable of putting the membrana basilaris on tension. The possibility of this epithelium being a specialized neuroepithelium has also been suggested. None of these theories seem very plausible after examining a number of sections showing these processes. I have made a study of this epithelium chiefly in the cochlea of the pig's ear and in that of the guinea pig, and I find that where these epithelial processes extend off into the underlying spiral ligament they invariably enclose in their centre a small tubule, which opens on the free surface of the sulcus externus, and is frequently somewhat dilated. The existence of these tubules has apparently been entirely overlookd by previous investigators. Their existence, I believe, explains the significance of this peculiar clump of epithelium occupying the sulcus externus. Epithelium surrounding tubules of this kind can have but one significance, that of a secreting

apparatus. This epithelium, therefore, must be a type of glandular secreting epithelium. Whether all or part of the constituents of the endolymph are secreted by these cells we have no means of knowing. It seems probable, however, that the stria vascularis may assist in the secreting of the endolymph. The full description of this structure, together with an account of its development and illustrated by a number of drawings will appear shortly in the Zeitschrift für Ohrenheilkunde. I have here a number of preparations illustrating the presence of these clumps of epithelium growing out into the spiral ligament and the presence of tubules occupying the centre of these clumps.

EXHIBITION OF A SPECIMEN OF A BULLET.

By DR. GEORGE L. RICHARDS, Fall River, Mass.

Dr. G. L. Richards, Fall River, exhibited a specimen of a bullet which a man had shot into his own ear ten years before. It was searched for without finding it. Followed immediately by facial paralysis and a total loss of hearing in that ear. Came under the doctor's observation with postaural fistula through the mastoid and passed on to a radical mastoid operation. The mastoid was found sclerosed. No evidence of the bullet was found until the radical operation was finished so far as the bone was concerned, but on curetting to be sure the area around the Eustachian tube was perfectly clean the curette brought up a little spicule of what looked like lead and with that as a lead the bullet was uncovered just under the facial ridge and underneath the foramen ovale. It was impossible to get around it until the Fallopian canal was chiselled away. The facial nerve as it was uncovered looked normal. He was able to lift the bullet out. The man states that he has a little more control of the mouth and doesn't run tears so much and the face looks a little better. Under galvanism the muscles contract. He asked if any one had had a case of facial paralysis lasting ten years with improvement after that time.

Discussion.

Dr. N. H. Pierce, Chicago, had had a case of facial paralysis resulting from operation for coolesteotoma with necrosis of the Fallopian canal in which the nerve was in all probability killed off for a distance of a half inch, in a child, which was exhibited before the Chicago Otological Society

after five years, when there was distinct functioning of the nerve. The paralysis could scarcely be detected.

Dr. F. L. Jack, Boston, knew of one case in which the function returned at the end of three years.

Dr. E. B. Dench, New York, had had one case where after four years the function materially returned.

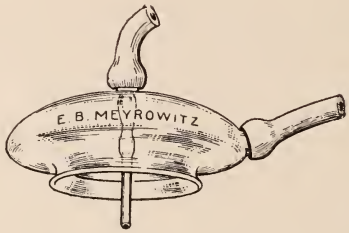
DESCRIPTION OF THE FOWLER DOUCHE.

By WENDELL C. PHILLIPS, M. D., New York.

Dr. Edmund Prince Fowler of my staff at the Manhattan Eye, Ear and Throat Hospital devised the instrument I desire to show you.

It is an ear irrigator so constructed that its action is not only safe, efficient, simple and cleanly, but it combines irrigation and suction at one and the same time.

A glance at the instrument will show you, more clearly than any verbal description, its construction and design. Being made of glass, a view of the parts under treatment is obtainable at all times, the glass bell is adapted to fit



snugly about the auricle, wholly enclosing it, preventing any leakage of irrigating fluid, and if the rim is accurately adjusted it will, except in a few very irregular skulls, make an air tight joint between the bell and the side of the head. The intake nozzle being smaller in diameter than the outflow tube, enables the apparatus to establish a partial vacuum when in use. This vacuum is brought about by the simple means of syphonage, and is proportional to the length of the drainage tube.

Dr. Fowler has found by actual experiments that about two feet of tubing is best adapted for ordinary treatment,

and that this amount of tubing will develop a suction equal to from twenty to thirty millometers of mercury. He also finds that in no case will this amount of suction cause pain, not even in normal ears.

The idea of the douche, aside from its irrigation property, is to efficiently establish and maintain drainage, to draw the pus and secretions from the deeper parts of the middle ear to the surface, and to then loosen and wash them away by the stream of irrigating fluid. Besides these actions a hyperemia is established and maintained for a definite length of time depending on the amount of fluid used. With a two quart fountain syringe full, it takes about twelve minutes to exhaust the supply of fluid. Patients seldom complain of the vertigo, which is so commonly produced by ordinary irrigations, and their ears feel more open and cleared after the use of this suction bell douche.

It is not adapted to remove inspissated cerumen, and if the external auditory canal is filled with hardened masses of pus or detritus, hydrogen peroxide or other means must be used to loosen these before the douche is applied. I have made use of this instrument in many cases and find it most efficient, in fact, it will often bring about resolution in acute suppurative otitis media and threatening or early mastoiditis in quite a marvelous manner. Dr. Fowler and others have, without incision, caused even subperiosteal abscesses to disappear, and I can substantiate these claims having seen the results. The douche may be safely intrusted to patients for home use, and is the only instrument of which I am cognizant, that patients may use, and be sure of properly irrigating their ears. With children it is often a most difficult feat to properly wash out the external auditory canal, without wetting all concerned in the operation. Fowler's douche enables us to easily hold the child's head between our two hands, and absolutely control it.

At the Babies' Hospital in New York city, they have found the douche most satisfactory and use it in all their cases with running ears. There is another feature of this douche

which I must mention and that is its ability to produce compression alone, or alternating with suction. This is done by simply compressing the outlet tubing, and maintaining firm pressure against the cup on the side of the head. The fluid will slowly rise in the bottom of the bell and compress the air contained therein, and necessarily also the fluid filling the auditory canal. You will readily see that this at times would be a very advantageous action.

The apparatus automatically fits about the ear in such a manner that the small rubber nozzle will take a direction inward downward and forward, thus coinciding with the axis of the auditory canal. The suction further aids the entrance of the fluid into the canal by drawing the auricle outward and upward and so straightens the canal. Lack of time forbids my going more into detail concerning the many good points of this little apparatus, but I believe I have brought to your notice and impressed you with its principal features.

NEW NASAL SPECULUM.

By E. TERRY SMITH, M. D., Hartford, Conn.

This nasal speculum which I am presenting to you was designed by my associate, Dr. C. H. Borden, and myself, and although really an improved Myles Speculum, might be called the Smith-Borden Nasal Speculum to avoid confusion.

The Myles nasal speculum is well known and requires no description. The improvement consists in adding to one arm a "checkered grip" and to the sleeve on the other side a serrated finger piece. The use and advantage of this improvement is shown in the illustration. A much better and firmer "hold" is possible and the manipulation is under better control.

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American Otological Society.

The Forty-second Annual Meeting of the American Otological Society was held at the Harvard Medical School Building, Longwood Avenue, Boston, Mass., June 1 and 2, 1909.

The following members were present:

DRS. JOHN L. ADAMS.....New York, N. Y.
GORHAM BACON.....New York, N. Y.
JOHN F. BARNHILL.....Indianapolis, Ind.
HERBERT S. BRICKETT.....Montreal, Canada.
WILLIAM C. BRAISLIN.....Brooklyn, N. Y.
JOSEPH H. BRYAN.....Washington, D. C.
W. SOHIER BRYANT.....New York, N. Y.
FRANKLIN P. CAPRON.....Providence, R. I.
CORNELIUS G. COAKLEY.....New York, N. Y.
EUGENE A. CROCKETT.....Boston, Mass.
J. FRANK CROUCH.....Baltimore, Md.
EWING W. DAY.....Pittsburg, Pa.
EDWARD B. DENCH.....New York, N. Y.
ARTHUR B. DUEL.....New York, N. Y.
GEORGE F. FISKE.....Chicago, Ill.
PERCY FRIDENBERG.....New York, N. Y.
EMIL GRUENING.....New York, N. Y.
THOMAS H. HALSTED.....Syracuse, N. Y.
PHILIP HAMMOND.....Boston, Mass.
THOMAS J. HARRIS.....New York, N. Y.
DAVID HARROWER, JR.....Worcester, Mass.
ERASTUS E. HOLT.....Portland, Me.
FREDERICK L. JACK.....Boston, Mass.
WALTER B. JOHNSON.....Paterson, N. J.
RICHARD JORDON.....New York, N. Y.
JOSEPH A. KENEFICK.....New York, N. Y.

D. BRADEN KYLE.....Philadelphia, Pa.
GEORGE A. LELAND.....Boston, Mass.
ROBERT LEWIS, Jr.....New York, N. Y.
JAMES E. LOGAN.....Kansas City, Mo.
DAVID B. LOVELL.....Worcester, Mass.
JAMES F. McKERNON.....New York, N. Y.
ROBERT C. MYLES.....New York, N. Y.
FRANCIS R. PACKARD.....Philadelphia, Pa.
NORVAL H. PIERCE.....Chicago, Ill.
WENDELL C. PHILLIPS.....New York, N. Y.
JOHN B. RAE.....New York, N. Y.
B. ALEX. RANDALL.....Philadelphia, Pa.
HENRY O. REIK.....Baltimore, Md.
J. SCOTT RENNER.....Buffalo, N. Y.
GEORGE L. RICHARDS.....Fall River, Mass.
CHARLES W. RICHARDSON.....Washington, D. C.
HENRY W. RING.....New Haven, Ct.
GEORGE E. SHAMBAUGH.....Chicago, Ill.
WARREN S. SHATTUCK, Jr.....Brooklyn, N. Y.
E. TERRY SMITH.....Hartford, Conn.
SARGENT F. SNOW.....Syracuse, N. Y.
FRANK B. SPRAGUE.....Providence, R. I.
EDWARD STIEREN.....Pittsburg, Pa
ERNEST de WOLFE WALES.....Indianapolis, Ind.
D. HAROLD WALKER.....Boston, Mass.

The meeting was called to order at 10 a. m. by the president, Dr. Frederick L. Jack of Boston, Mass., who appointed as a Business Committee, Drs. Emil Gruening, George E. Shambaugh, and E. A. Crockett.

The Treasurer's report was read, and on motion of Dr. Dench was accepted and placed on file.

The Secretary read the resignations of Drs. W. H. Carmalt, G. C. Harlan, R. G. Reese, and Lucien Howe.

On motion of Dr. Phillips the resignations were accepted with regret.

The Secretary read a letter from the Committee upon the establishment of a new Journal of Otology and Laryngology, reporting that they found the plan not feasible.

Upon motion of Dr. Dench, the report was accepted.

The Secretary read a letter referring to the George Washington Memorial Building, asking for the co-operation of the Society, which, on motion of Dr. Dench, was laid on the table.

In the absence of a report from the Committee appointed to extend an invitation to the International Congress of Otologists at their meeting in Budapest this year to hold their next meeting in America, Dr. Edward E. Dench moved that the Society extend to the International Otological Society at its meeting in Budapest this year an invitation to hold its next meeting in New York city, which motion was carried.

The Executive Session then adjourned.

Dr. Eugene A. Crockett, Boston, read a paper on The Treatment of Acute Suppurative Leptomeningitis of Otitic Origin by an Early Operation and Subdural Drainage with Report of Four Cases.

Discussed by Dr. D. Harold Walker, Boston; Dr. B. Alex. Randall, Philadelphia; Dr. Edward B. Dench, New York; Dr. Percy Fridenberg, New York; Dr. James F. McKernon, New York; Dr. Gorham Bacon, New York; Dr. Norval H. Pierce, Chicago; Dr. J. F. Barnhill, Indianapolis; Dr. Charles W. Richardson, Washington; Dr. Emil Gruening, New York; Dr. Wendell C. Phillips, New York; Dr. Arthur B. Duel, New York; Dr. Frank B. Sprague, Providence; and in closing by the essayist.

Dr. Norval H. Pierce, Chicago, read a paper on Report of a Case of Large Cerebellar Abscess, with Recovery.

Discussed by Dr. Edward B. Dench, New York; Dr. B. Alex. Randall, Philadelphia; Dr. Wendell C. Phillips, New York; Dr. Arthur B. Duel, New York; and in closing by the essayist.

Dr. Edward B. Dench, New York, read a paper on Report of Two Cases of Brain Abscess.

Discussed by Dr. J. F. Barnhill, Indianapolis; Dr. James F. McKernon, New York; Dr. Wendell C. Phillips, New York; Dr. Charles W. Richardson, Washington; and in closing by the essayist.

Dr. Percy Fridenberg, New York, read a paper on A Review of Some Recent Theories of the Labyrinth.

Discussed by Dr. George E. Shambaugh, Chicago; Dr. E. Alex. Randall, Philadelphia; and in closing by the essayist.

Dr. D. Braden Kyle, Philadelphia, read a paper on Subjective and Objective Sense of Sound Perception.

Discussed by Dr. George E. Shambaugh, Chicago; Dr. Edward B. Dench, New York; Dr. B. Alex. Randall, Philadelphia; Dr. Norval H. Pierce, Chicago; and in closing by the essayist.

Afternoon Session, June 1, 1909.

The meeting was called to order, Dr. F. L. Jack, presiding.

The Secretary read a communication from the Congress of American Physicians and Surgeons in reference to the next meeting of the Congress in Washington.

The Secretary announced that the American Laryngological Society extended an invitation to the American Otological Society to hold a joint session at the meeting of the Congress in Washington.

On motion of Dr. Phillips, this matter was left to the President and Secretary with full authority to act.

The President announced that the Society was indebted to Dr. Wales for the alphabetical index and asked for a vote of the Society as to whether it desired to have the index continued.

On motion of Dr. Randall, the Society extended a vote of thanks to Dr. Wales and requested a continuation of the index.

The Committee on Membership, Dr. Robert Lewis, Jr., Chairman, presented its report.

For election to membership, Drs. MacCuen, Smith, Spencer, Roberts, and Dunn, and recommended that the name of Dr. Tobey be carried over until next year.

Recommended the following officers:

President—Dr. Frederick L. Jack, Boston.

Vice President—Dr. Richard A. Reeve, Toronto.

Secretary and Treasurer—Dr. James F. McKernon, New York.

Committee on Membership—Dr. Robert Lewis, Jr., Dr. H. O. Reik, and Dr. Norval H. Pierce.

Committee on Publication—Dr. Gorham Bacon, Dr. B. A. Randall, and the Secretary, ex-officio.

The Society instructed the Secretary to cast a ballot for the recommendations of the Committee, which was accordingly done.

The President announced that the By-Laws required the appointment of a standing committee on Program, and he appointed Dr. James F. McKernon, Dr. Edward B. Dench, and the President, ex-officio.

Dr. Percy Fridenberg moved a reconsideration of the question of the invitation to the International Otological Society to hold its next meeting in this country, which motion was carried.

After some discussion, on motion of Dr. Wendell C. Phillips, the Society voted that the Committee be instructed to invite the International Congress of Otology, at its meeting in Budapest this year, to hold its next meeting in New York, and, if possible, upon a date that will meet the weather conditions in that city.

Demonstration of Instruments:

Dr. Percy Fridenberg exhibited and demonstrated an electric pharyngoscope, an instrument for the rapid and direct examination of the pharynx and larynx.

Dr. Norval H. Pierce exhibited a new tonsil separator, a tonsil snare, tonsil hemostat, and tonsil cocaine syringe.

Dr. W. Sohier Bryant, New York, read a paper on Sound Perception.

Discussed by Dr. George E. Shambaugh, Chicago; Dr. B. Alex. Randall, Philadelphia; and in closing by the essayist.

Dr. John B. Rae, New York, read a paper on Brief Report of Two Cases of Sinus Thrombosis.

Dr. Thomas H. Halsted, New York, read a paper on Report of Cases of Sinus Thrombosis.

Discussed by Dr. Edward B. Dench, New York; Dr. J. F. Barnhill, Indianapolis; Dr. Percy Fridenberg, New York; Dr. Norval H. Pierce, Chicago; Dr. Charles W. Richardson, Washington; Dr. Wendell C. Phillips, New York; Dr. J. B. Rae, New York; and in closing by the essayist.

Dr. Arthur B. Duel, New York, and Dr. Jonathan Wright, New York, read a paper on The Clinical and Pathological Significance of Bacteraemia in Purulent Otitis.

Discussed by Dr. Libman, New York; Dr. Emil Gruening, New York; Dr. James F. McKernon, New York; and in closing by Dr. Duel, New York.

Morning Session, June 2, 1909. Joint Session.

A Symposium was presented on Nasal and Pharyngeal Conditions as Factors in the Causation of Aural Disease by Dr. Cornelius Godfrey Coakley, New York, and Dr. D. Braden Kyle, Philadelphia, representing the American Laryngological Association; and Dr. George A. Leland, Boston, and Dr. Norval H. Pierce, Chicago, representing the American Otological Society.

Discussed by Dr. E. A. Crockett, Boston; Dr. Otto T. Freer, Chicago; Dr. W. L. Ballinger, Chicago; Dr. G. L. Richards, Fall River; Dr. Emil Mayer, New York; Dr. Percy Fridenberg, New York; Dr. Emil Gruening, New York; Dr. George E. Shambaugh, Chicago; Dr. W. K. Simpson, New York; Dr. J. F. Barnhill, Indianapolis; Dr. C. Hudson Makuen, Philadelphia; Dr. J. Payson Clark, Boston; Dr. F. B. Emerson, (by invitation); Dr. B. Alex. Randall, Philadelphia; and in closing by Dr. George A. Leland, Boston; Dr. N. H. Pierce, Chicago; Dr. James E. Logan, Kansas City; and Dr. Francis R. Packard.

Afternoon Session, June 2. Executive Meeting.

The meeting called to order, Dr. F. L. Jack, Boston, presiding.

Amendment to Section 2 of the By-Laws; after the phrase "setting forth the claim of such candidates for membership" to read as follows:—That there shall accompany his application for membership evidence that he has the proper scientific attainments to fit him for the active work of the Society, this evidence may be in the form of a published, or unpublished thesis,—was on motion of Dr. Berens adopted.

Dr. Gruening's amendment to the instructions to the Secretary to notify members that they must sign the roll at least every three years—that the rule should apply only to members who have not been in the society for twenty years or more, was adopted.

Dr. T. Passmore Berens, New York, gave an Exhibition of Specimen; Sequestrum of Petrosa.

Discussed by Dr. Norval H. Pierce, Chicago; Dr. B. Alex. Randall, Philadelphia; and the essayist.

Dr. George E. Shambaugh, Chicago, read a paper on The Significance of Certain Labyrinthine Symptoms.

Discussed by Dr. Percy Fridenberg, New York; Dr. B. Alex. Randall, Philadelphia; and in closing by the essayist.

Dr. William C. Braislin, Brooklyn, read a paper on (a) A Study of Some Casts of the Infantile Pharynx, with Special Reference to the Eustachian Tubes. (b) A Note on Eustachian Obstruction.

Discussed by Dr. B. Alex. Randall, Philadelphia; Dr. George E. Shambaugh, Chicago.

Dr. Sargent F. Snow, Syracuse, read a paper on Autotoxic Deafness.

A paper on Post-nasal Discharge and Aural Discharge in Children, by Dr. Percy Fridenberg, New York, was read by title.

A paper on Structure of the Mastoid Cortex in Relation to Septic Invasion, by Dr. Clarence J. Blake, Boston, was read by title.

A paper on The Pressure Factor in Auditory Vertigo, by Dr. Clarence J. Blake, Boston, was read by title.

A paper on Radical Removal of the Tonsil, by Dr. Charles W. Richardson, Washington, was read by title.

Dr. James F. McKernon, New York, read a paper on Presentation of a Specimen (Sequestrum of Entire Labyrinth) with Report of a Case.

Discussed by Dr. F. L. Jack, Boston; Dr. George E. Shambaugh, Chicago; Dr. B. Alex. Randall, Philadelphia; Dr. Norval H. Pierce, Chicago; and in closing by the essayist.

The Society extended a vote of thanks to the Boston colleagues, and to the President particularly, for the entertainment given.

Adjournment.

By invitation Dr. Percy Brown, Boston, gave An Exhibition of Skiagraphs Showing the Normal and Pathological Accessory Sinuses of the Nose.

This exhibition was outside of the regular meeting room.

J. F. McKERNON, Secretary.

THE TREATMENT OF ACUTE SUPPURATIVE LEPTOMENINGITIS OF OTITIC ORIGIN BY AN EARLY OPERATION AND SUBDURAL DRAINAGE WITH REPORT OF SIX CASES.

By EUGENE A. CROCKETT, M. D., Boston, Mass.

This paper has been in process of preparation for several years; that is, I have performed the type of operation described in this paper for about six years and the conclusions are based upon a larger number of cases than are reported here. While preparing this article I came across one by G. Alexander, of Vienna. (Archiv für Ohrenheilkunde, May, 1908.) (From the ear department of the General Polyclinic, Vienna), (Clinical Studies on the Surgery of Otogenous Meningitis), which is extremely interesting to me because his conclusions coincide with my own experience and as you will see from the report of these cases his operative measures and reasons for operations are very similar.

The first case has been reported before at a meeting of the A. L. R. O. Society in 1905. I report it here again in order that it may be included in this series.

A woman, 33 years old, who had chronic discharge from the right ear many years with an indefinite history of tenderness in right mastoid nine months and acute pain for six months. Nine weeks before admission to the hospital she had an attack of severe pain in the right ear, accompanied by nausea, vomiting and vertigo. A paracentesis was done on the right ear after four days of these symptoms and later some polypi were removed from the external auditory canal. This pain continued at intervals until admission to the hospital, a period of nine weeks. Two days before admission she had an attack of severe frontal headache, loss of consciousness for twenty minutes, nausea, vomiting, and vertigo continued over two days, and numerous severe chills.

On examination the right ear showed a very large polyp projecting out into the concha, the middle ear could not be seen, but coming around the polyp was a discharge of very fetid pus, but no mastoid tenderness. I happened to be present at the hospital when she arrived. She was at that time conscious and complained of headache, vertigo, nausea and chilly sensations. Her temperature was 103. The examination of the ears showed a large polyp projecting out in the external auditory canal into the concha, the middle ear could not be seen, and there was no mastoid tenderness or oedema. There was a slight discharge of foul smelling pus. Her general condition was very poor.

She was etherized as soon as admitted to the house. A curved incision one and a half inches long was made above the auricle and about four inches long. The skin flap was reflected downward and the squama exposed and an opening about one inch in diameter was made with a chisel and rongeur about one inch above the auditory canal. The dura was exposed and appeared to be thickened and yellow and the pia was also exposed. The small veins of the pia showed a line of yellow pus parallel to them. A grooved director was inserted in the brain substance in a direction downward and forward and also inward, but no pus was found. There was some protrusion of brain substance and a small cerebral hernia. The dura was sutured with cat-gut and a gauze wick left between the dura and pia. The patient did perfectly well and was discharged from the hospital on the 21st day of July (18 days after the operation), with her wounds absolutely healed.

In this case nothing was done to the mastoid nor was the middle ear touched other than remove the polyp with a curette. The patient's condition was so desperate that it was not deemed advisable to prolong the operation any further and the after treatment of her case certainly justified this decision. I attribute the recovery in her case entirely to the rapid relief of the intra-cerebral pressure afforded by the constant oozing of the cerebral spinal fluid.

Second Case. A man 29 years old admitted to the hospital January 2, 1905. His history was that he had a discharging ear for four weeks before admission, during which time he had severe headache, dizziness and considerable vomiting for the last three days. He had an almost complete atresia of the canal, admitting only a very fine middle ear probe which brought out foul pus. There was a cicatrix over the mastoid process, left ear, extending down into the neck, but he did not remember when this scar was received. There was slight tenderness of the mastoid antrum. The pupils were pin point and did not react to light, but he had been for several days under opiates. The left patellar reflex was very sluggish, the right normal. The skin reflexes were diminished on the right side and the fundi were negative.

On January 3, 1905, he was etherized and his mastoid opened. The periosteum was very adherent and cortex of the bone very thick. The middle ear, canal, and antrum was found to compose one large cavity with over-hanging edges filled with foul cholesteatomatous masses. On removing this a perfectly smooth bone cavity was seen. The facial ridge and Eustachian tube opening were the only landmarks to be recognized in the middle ear. The rest of the mastoid bone was sclerosed. The canal was split into Panse flaps and the cavity packed. The temperature continued elevated after the operation and on January 6th, three days afterward, the temperature rose to 104, pulse 70. There was a slight aphasia and the reflexes were the same as on admission. He had a good deal of frontal headache and the wound was dressed three days after the operation and the cavity was found clean. On account of high temperature and low pulse a further operation was deemed advisable, and on January 7th a U-shaped incision was made over the auricle and the squamous portion of the temporal bone trephined. A crucial incision was made in the dura and the brain was found to be dark and nonpulsating. A director was inserted in the brain, but no pus found. A considerable amount of cerebral fluid was allowed to escape and a gauze

wick was inserted under the dura. The bleeding vessels were ligated and drainage left at the lower portion of the wound. The wound was dressed on January 9th and 11th. On the second dressing the gauze was removed and a considerable amount of hemorrhagic fluid evacuated, including some material resembling brain substance. The mastoid wound was found clean and there was some hernia of the brain.

Between January 11th and 18th he had some delirium at times, but most of the time was rational except after talking a few seconds his aphasia would be noticeable. His reflexes were normal. His temperature varied between 100 and 102, and on February 16th a little over a month from his first operation, his mental condition gradually improved. The wound was then closing in slowly and the granulations in the radical cavity were firm. The temperature at this time varied between 98 and 100. At times he was incoherent and other times perfectly normal mentally. This was his best point, and from this time on he went downward, having some stupor and increased difficulty with his speech, until on February 24th his mental condition was very bad. He was very drowsy and failed to recognize his parents and talked continually and incoherently. His fundi were still normal and leucocytes—14,000 whites. The original large mastoid incision was enlarged still further,—the tegmen tympani and antri were found to be soft and covered with granulations which were removed and the dura was exposed. The dura was opened with a knife over the antrum. A grooved director was passed through the same incision and withdrawn, followed by a gush of pus in a large quantity. Scissors were then inserted 4-5 cm. opened and withdrawn and the pus continued to drain for several minutes and a quarter of inch drainage tube was passed in the incision. At this moment the pulse dropped from 110 to 80 per minute.

February 25th—Patient delirious and with incoherent speech. His eyes turned strongly to the right, but no distinct facial palsy on either side. He recognized his sister

this morning and seemed to understand for a few minutes what was said to him. He did not reply when I asked him to put his tongue out, but responded: "Yes, I feel a little better." In the evening of this day, twenty-four hours after the second operation Cheyne-Stokes were observed with pulse of 50 and continued twitching of right arm. His eyes did not turn so strongly to the right but were continually moving. There was considerable discharge of fetid pus coming from the wound and he died forty eight hours after the second operation.

In this case there can be very little question but what the operation of subdural drainage done on the 16th of January gave this man at least a month of very comfortable existence, but of course in the presence of unrecognized sphenoidal abscess it failed in the end to bring about a favorable result.

(Notes to be added to the account of the patient with sensory aphasia, at the Eye and Ear Infirmary.

James J. Putnam, M. D.)

"It was very marked at my examination, that although the fluency of the patient's speech seemed to suggest a desire and ability of what was said to him. It was difficult to appreciate this for another reason, namely, because occasionally he would understand fairly well some simple question. His mental condition seemed to be fairly clear, though rather excited and it was obvious to me that he was watching the expression of the face and responding to questions that he thought were being asked. Thus: I asked him first how he felt and he said (not without some errors), 'I feel pretty well. Did not feel very well yesterday, but feel better today, and kept repeating this in substantially the same words over and over again, even when I asked him whether he had pain in his head or told him to put his tongue out. His manner in short was that of a person in slight mental confusion, but mainly suffering from deafness, yet trying to guess what was said to him. Finally, I asked him over and over again to put out his tongue and after repeating the

above answer several times he finally put his tongue out and then did this a number of times over at request. It should be said that the hearing in the unaffected ear was good."

Case 3. H. U., 16 years old, admitted to the E. E. I. on May 1st, 1906. The history was that six days before admission he had acute inflammation of the right middle ear on which a paracentesis was done after two days of pain. The day after the paracentesis he vomited four times and had some pain in spine and back of the neck and headache, in fact he had had some frontal headache since the first pain in the ear.

Examination—Six days after the beginning of the symptoms there was a granulation on the wall of the canal near the drum membrane. The drum membrane was thick and there was some oedema of the canal wall but no mastoid tenderness or oedema. The white count was 21,000 white cells. There was a profuse serous discharge from the middle ear.

There was marked retraction of the head with stiffness of the neck muscles and along the spine, the latter appeared tender particularly at region of lumbar vertebrae. All the reflexes were normal except for a possible Kernig. The fundus was normal. The lumbar puncture showed a turbid fluid which showed nothing abnormal under the microscope. That evening the temperature was 104, the next morning 103. A lumbar puncture was again performed and about 10cc. cerebral-spinal fluid removed. The smear showed many polynuclear leucocytes, but no bacteria. The culture from this fluid said, "Diplococcus not found. Lymphocytes." The following day the temperature dropped to 98.4 but in the afternoon went up to 102.5. The patient felt better, with less pain, but again on May 4th, the minimum temperature was 101 and white count 15,000. There was a good deal of stiffness and pain in the back of the neck, knee jerks were not obtainable, but positive Kernig on both sides and another lumbar puncture was done to relieve pressure. The minimum temperature for four days was not over 100.5, but

the patient still maintained rigidity of neck and positive Kernig. The middle ear cleared up. A period of relief was obtained by use of lumbar puncture for a period of 14 days, but on May 18th, the patient, in addition to his other symptoms had a marked nystagmus, became delirious and had an increase of all symptoms and an operation was decided upon. An area about two inches square in the skull just posterior and above the mastoid was trephined by the use of a one-inch trephine and enlarged with rongeur forceps. The dura was incised with resulting hernia of the brain. The brain substance was dark and suggested an encephalitis. A probe was introduced between the dura and skull and between the dura and brain without obtaining evidence of pus. A small selvage wick was passed through the dura. The patient did not recover consciousness after the operation and died about three days afterward, the temperature not going over 101 and pulse 80 and 90.

Case 4. R. W., 25 years old. First seen February, 1907. A paracentesis was done for the relief of acute infection of the right middle ear. The middle ear continued the usual course with granulations and increased mastoid tenderness until the last of March, when a mastoid operation was decided upon.

It had previously been difficult to discriminate between a mastoid infection and furunculosis of the canal. The symptoms of mastoiditis were not severe and an operation was performed on March 30, 1907, and for a week following the patient did as well as could be expected. There was an increased stupor and rise of temperature until on April 15th his temperature had reached 104 and his pulse at the same time was between 50 and 60. He was distinctly stupid and there was a question of Kernig though his reflexes were normal. His white count was 23,000 whites and examination of fundus negative.

After a consultation it was decided there was some cerebral process and an operation was deemed necessary. The mastoid was reopened and thoroughly explored and a few

pus cells were found in the root of the Zygoma which had been overlooked in the former operation. The sinus was uncovered and appeared to be normal. The bone opening was then extended with a rongeur in the direction above, forward and over the middle ear. The dura bulged but did not pulsate. On opening the dura some cerebral fluid with only a few drops of pus immediately escaped and large hernia of the brain followed. An exploration of the interior of the brain showed no further trouble. The skull opening was enlarged with some difficulty. A wick was again passed in the subdural space.

Following this operation the patient continued to improve in spite of the large hernia of the brain which kept the flaps of the wound apart for two months and which became infected either through dressings or the presence of pus in the cerebral cavity, at any rate it was covered with a profuse discharge of pus for four weeks. This patient's wounds healed about the first of July and the middle ear is now normal. The patient's condition is perfectly good at the present time with no further symptoms from the operation.

Case 5. A man, 35 years old, was seen for acute inflammation of the middle ear requiring a parcentesis in October, 1907. The drum was opened under gas about five o'clock in the afternoon. The ear had never troubled the patient before and had been paining only four hours. The paracentesis was followed by a profuse serous discharge, but about twelve hours afterward the patient became wildly delirious with a temperature of 105. It was impossible to obtain his reflexes on account of the violence of his delirium and a diagnosis of meningitis was perfectly easy to make.

He was etherized and this same operation which I have formerly described, was performed about 18 hours after the paracentesis. The mastoid was not opened on account of the bad condition of the patient necessitating being quick with whatever was to be done. The skull was trephined over the auricle and the dura opened and there was considerable escape of cerebral spinal fluid. A subdural drain was put in

and the wound sewed up. The patient rapidly failed and died after the operation about three days from the beginning of the ear ache.

Case 6. A man, 56 years old, seen in April, 1908. He had an acute inflammation of the right ear, following an influenza infection in which a paracentesis had been performed four hours before I saw him. A profuse serous discharge followed the paracentesis and for four days he was up and about but complained of a good deal of prostration and had some headache and on the day I saw him he had some vomiting and complained of severe frontal headache. His temperature was 102, there was a suspicion of Kernig, but his other reflexes were normal. His pupils were quick to react to light. The fundi oculi was not examined. The question lay at this time between an abscess of the frontal sinus or possibly a beginning meningitis. The ear appeared as we would expect it to after an acute inflammation of the middle ear on which a paracentesis had been done four days before. There were no mastoid symtoms whatever. Twelve hours after I first saw him he became delirious and there was then no question about diagnosis of meningitis. Kernig was obtained on both sides.

He was etherized and a rapid mastoid operation showed much to my astonishment, a thick outer cortex with about thirty drops of clear pus in the interior of the bone, although he had an early paracentesis and only four days from the paracentesis to my operation and he had no mastoid symptoms whatever. The bone opening was prolonged up over the middle ear and mastoid with a rongeur. The dura bulged in the wound before it was opened and on opening the dura there was immediately a well marked hernia of the brain. A lumbar puncture was performed hoping to reduce the pressure and hernia. About 20cc. cloudy was drawn off, the fluid coming drop by drop and apparently under no pressure whatever, in fact it was extremely difficult to get it to flow at all. The draining off of this fluid did not relieve the hernia in the least and a subdural drain could not be

inserted in this case without risk of brain substance, so it was not attempted. The wound was sewed up and the patient taken off the table and remained in good condition four hours after the operation, when he died almost instantly of respiration failure. A report by Dr. Mead is as follows:

> Cloudy serum from lumbar puncture. Few flakes of fibrim in sediment which consists of numerous pus cells with streptococci in and outside the leucocytes. Culture shows growth of few colonies of streptococci, pure culture.

Here we have six cases of undoubtedly acute lepto meningitis, with two recoveries. This comprises all the cases I have seen and operated upon since January, 1904. I have, however, in that time seen several other cases too far gone to operate upon. But two recoveries in six cases certainly to my mind justifies the performance of this operation, because it is beyond question that the two here reported would have had fatal results without operation. In this class of cases almost everything is justifiable which promises the slightest hope of ultimate recovery.

The most striking thing in this series of cases is the relief which is early afforded by opening the cerebral cavity even in the cases where ultimately the result was fatal.

In cases two and three of this series the opening of the cerebral cavity relieved the cerebral pressure and the free use of lumbar puncture afterward to keep the pressure down undoubtedly gave these patients three or four weeks of living of which they were conscious and reasonably comfortable. In the other two cases which died, the infection was of a most purulent and rapid type. In one case the history was of acute trouble only three hours and the other four days.

We have all of us found in post mortem findings that the patient has evidently had meningitis for a very long time and lived through the first stage with an increase of cerebral pressure and going into a second stage of subacute meningitis so that often at post mortem examination the

fluid can be taken from the cranial cavity with a teaspoon and a patient in this condition may show so few symptoms of meningitis to make accurate diagnosis almost impossible.

If we can by relieving the increased tension on the medulla get the patient through the first stage of the disease it is not impossible that we may see an ultimate recovery. This is clearly shown in the first and fourth cases of this series.

Are we able to select the type of case in which operation may probably be more favorable?

In reading Alexander's article, "Arch für Ohrenheilkunde, July, 1908," the summary of this point so absolutely agrees with my own experience that I am inclined to quote it exactly. "One very important factor in the question of curability of purulent meningitis is certainly the virulence of the exciting cause. All investigators have spoken of this and it is unanimously inferred and conceded that the hope of cure of an otitic, infectious purulent meninigitis is in the slight degree of virulence of the cause of purulence. In view of these experiences, we must not, of course, go further, and perhaps infer that we were always dealing with very slightly virulent and possibly with degenerate microorganisms. But a second factor seems to me even more important, and this consists in the form in which the meningitis began. The more acute and violent was the progress of the first symptoms, the more unfavorable is the prognosis. An initial stage of long duration and symptoms which are extensive but ill-defined, give a better outlook to the case in a prognostic way. Still there is no doubt in my mind that in the end all stress must be laid on the important and benevolent role played by meningeal agglutinations in the cure of meningitis, for by these, meningitis is encapsuled and a general meningitis is averted. In the many cases of purulent meningitis which I observed clinically and anatomically at Politzer's clinic, when I was an assistant, I was able to observe these completely but once (see case 4.) Judging by what we learn at autopsies, I do not believe that these agglutinations, when they do occur, could keep the menin-

gitis encapsuled. At autopsies we often see meningitides of limited area, especially at the base of the brain, which have remained circumscribed, though lacking agglutination, and, on the other hand, cases of general meningitis, have demonstrated, on section, the impotence of these supposed agglutinations.

I believe that the form of the development of an otitic meningitis is given by the very first attack. Meningitides which arise as direct continuation of a local, purulent process in the ear region have generally an abscess-character at the start, retain this and remain localized. The more distant effect a purulent meningitis is (of ear affection), the sooner it will become general meningitis. We may thus infer that in addition to the clinical signs of meningitis the condition found on operating may give a probable diagnosis on the extent of the meningitis. If the inflamed changes reach from the organ of hearing in a limited area to the dura and into the dura, there will probably be partial, encapsuled or a limited meningitis. If the purulent affection extends from the organ of hearing and stops short of the dura, general meningitis is indicated.''

I am claiming no priority of idea in presenting this operation, although I have, I think, reported cases of leptomeningitis with successful operation. Successful operations of streptococcus, diplococcus, pneumococcus, bacteria coli meningitis have been reported by Arnold Knapp, Gradenigo, Bertelsmann, Brieger, Grossmann, Gruening, Leutert, Majean, Manasse, Preising, Schencke, Schulze and Sokolowski.

This operation has been my routine for the last four or five years and I have yet seen no reason to regret it, as I can certainly point to two cases whose lives have been saved by the operation and who are well and strong, showing no evidence of cerebral discharge or otherwise, in the one case five years ago and the other two and a half years since the operation.

Discussion.

Dr. D. Harold Walker, Boston: Dr. Crockett has certainly covered the ground very thoroughly. As regards lumbar puncture we know that a great many punctures are performed where one finds only clear fluid, but it is under pressure. In this case perhaps it is due to some other cause, as a general toxemia. This is especially true if the case happens to be one of aural complication. Reports have been made where one has found leucocytes in the fluid and the case recovered without operation, but it seems to me where there is aural complication operation is indicated, and should be performed at the very beginning. Lumbar puncture is not sufficient of itself because the intracranial pressure may shut off the brain from the cord and a strangulation occur. I know of one death caused in this way.

Another point is that of brain hernia. Aural surgeons are apt to do too much; they are not content to uncover the dura and wait, which is often the best thing to do. Last year I had a case of a young woman who suffered from chronic disease of the middle ear for a great many years and suddenly had pain in the region of the mastoid and back of the head, with chills, nausea, vertigo and vomiting. Two or three weeks after when I saw her she was more or less irrational; temperature 103—4. She had double optic neuritis; middle ear filled with large polyp; slight increase of white cells; nausea, vomiting, and vertigo still persisting. We thought it probably abscess of the brain. Upon operation the dura was bluish, but no pus. A probe was passed into the brain but no abscess found. Then because of the vertigo and pain in the occipital region we thought it best to trephine and examine the cerebellum that was also negative. The patient recovered and is living today. The optic neuritis cleared up entirely and she is apparently perfectly well. She has changed markedly as to her disposition; where she was formerly cross she is no longer so. Whether the cure was due to the relief of pressure or not I do not know, but it seems to me there are two very important

things; first, early lumbar puncture, to identify the organism if possible, and establish diagnosis and form autogenous vaccine; second, thorough drainage.

Dr. B. A. Randall, Philadelphia:—We have all had these cases, most of them unfortunate, but most of us who have had them can also claim cases of recovery, after, if not because of our operative interference. I would like to bring out one point particularly, in regard to the precipitation of serious results. I saw some years ago a clear case of meningitis which I felt should have operative interference. I advocated operation and irrigation using a canula which I have devised for the purpose and which enables one to irrigate the arachnoid cavity. This was refused and even lumbar puncture was negatived. My opinion was that the patient would probably die but not so soon with such intervention. I turned my back and she was dead before I reached the railroad station. Now if I had done a lumbar puncture the death would have been accredited to that. When Dr. Crockett says operation precipitated the death in his case I think perhaps he is not just to himself, for it may occur without relation to the operation. Generally the matter is now where reasonable work can be safe and I believe that for the expert the operation is strongly to be advocated; but we should be careful how we place the matter in the hands of the youngsters who might operate in improper cases. We must, however, offer to the friends and relatives the possibility that sudden death may result from or rather in spite of operation.

As to vaccine therapy, I think there is great future along that line. The magnificent results obtained with the Flexner serum encourages me to think that there is a great future for the serum treatment of these other cases. The great difficulty at present is how to get a proper serum. I lost a case recently where first investigation seemed to show the intracellular organism and I used the Flexner serum; but found at the second puncture that the organism was the

pneumoccus, and we did not get a report on that in time to get a pneumococcic serum. I believe that in some cases this will be our only hope.

Dr. Edw. B. Dench, New York:—I am very much interested in this subject and have been looking into it a good deal because I have been asked to write on the subject for the Congress at Budapest and I was surprised to find that out of 100 cases taken at random, of otitic meningitis, nearly 50% recovered as the result of operative interference. A very fair proportion of these were cases of diffuse meningitis. So I think we should approach the subject with a good deal of hope knowing that without such interference these cases must of necessity result fatally.

Dr. Walker suggests going slow in operating. I had a case this winter which recovered after a very simple operation. The patient had well marked symptoms of meningitis and when I opened the mastoid I felt certain that I would drain the subdural space. I found a good deal of infection in both mastoid processes, and exposed the dura freely below the tentorium and delayed puncture of the dura. One lumbar puncture had been done the week before. We are lead to believe that exposure of the dura doesn't relieve tension but it did in this case for the child made an interrupted recovery. The patient had been suffering with the attack two weeks before intervention.

I reported before this society in '96 a case of meningitis treated by subdural drainage with recovery. I have done a good many operations for the conditions since then and my results have been fairly satisfactory. In a case which I shall report in my paper today a ventricular drainage relieved the symptoms after a period of a month or six weeks.

It seems to me it is merely a question of steady work in this field before we are going to have very good results. In some cases ventricular drainage will do good. Last week I had a case which I kept alive six days by drainage of the lateral ventricle. One point of importance is drainage of

the sac below the tentorium. We know from investigation at autopsy that most of the cases are infected through the labyrinth, and in some of the recent cases I have been attempting to drain the posterior system first, I believe there is something in this point of draining the subdural space where infection has probably made its entrance. If we drain there we have a better chance than if we drain at a region more remote.

It is better to have the skull opened before much fluid is drained off to prevent the crowding down of the medulla into the spinal canal and thus causing sudden cessation of respiration. Unless the fluid can escape from above we may have this occur.

Dr. Percy Fridenberg, New York:—From a theoretical standpoint it would be instructive if we could analyze the curative action in these cases and find out which is the important factor; whether it is the reduction of increased tension, the removal of a certain amount of purulent material, or whether the opening of the subdural space and the admission of air has a beneficial effect in lessening the virulence of the bacteria and exhibiting further development. We know that the air does act in this way when the abdomeal cavity is opened and drained in tubercular peritonitis. Whether bacteriological tests would throw any light on the subject I do not know, but it occurs to me we might in this way get at the real basis of the results.

Dr. James F. McKernon, New York:—Two years ago I reported before the New York Otological Society, at the Academy of Medicine, a case of purulent meningitis where subdural drainage had been done following extensive mastoid operation, with recovery. A case which I have to report today is of the same type.

Dr. Fridenberg speaks of the doubt as to what is the curative element; it seems to me we have all had cases do well where lumbar puncture has been performed, but personally,

I have never seen a purulent meningitis recover from lumbar puncture alone.

Dr. Crockett speaks of his drain; as I understand it, with gauze and of the difficulty, particularly in one case, in the introduction of the drain on account of lack of space. I think that difficulty can be obviated to a certain extent by taking chromocized gut covered with cargyle membrane. It occupies less space, about one-eighth of the average drain, and is sufficient for drainage purposes. You can insert two or more drains of that type and thus get a very wide area drained.

I find the whole secret of the success of subdural drainage is early operation.

Dr. Gorham Bacon, New York:—The remark made by the last speaker as to early operation is a very important one. It recalls to my mind a case I reported some years ago when the patient had severe infection with symptoms of meningeal involvement, with a very low respiration, and I telegraphed the family giving a very grave prognosis. I opened up the middle fossa, examined it and found more or less congestion of the dura and apparently a commencing meningitis. I found the sinus normal and explored the tempero-sphenoidal lobe but found nothing. It was apparently a case of commencing meningitis. The patient immediately improved and I think the important point was that the operation was performed early. The local depletion of blood was undoubtedly beneficial to the patient, who promptly recovered.

Dr. Norval H. Pierce, Chicago:—Two weeks ago last Saturday, a child nine years old was brought to the clinic with intense headache, stiff neck, nystagmus, temperature of 102, history of chronic running ear on the right side. The skull was opened and the so-called arachnoid drainage established and the patient went into a state of unconsciousness, and died 36 hours afterward. This is simply a type of the cases that I have had experience with in my endeavors

to cure meningitis, and believe that a general purulent meningitis is incurable by operative procedure.

One point that I wish to make is this, that a localized meningitis undoubtedly gets well, although it may be of quite severe type. Now is it not possible that with operative interference we are going to change a good many of these cases of localized meningitis into a general diffuse meningitis.

Dr. J. F. Barnhill, Indianapolis:—As to cerebral hernia, that is a feature of the operatiion that sometimes occurs and is certainly very troublesome, so much so indeed that even if the patient gets well it prolongs recovery and is a complication of great inconvenience and annoyance. Where the hernia is very great and where the dura bulges immediately after opening the skull we have strong reason to suspect that there is cerebritis along with meningeal inflammation. Following a suggestion offered by Cushing some years ago I now lift the patient's head as soon as the bone is removed from the dura, and bulging is seen, for the reason that the erect posture of the patient will greatly favor the retraction of the dura. I also believe that it is sometimes a good practice in such cases to make a lumbar puncture before the dura is opened in order that a moderate amount of cerebro-spinal fluid may be drawn off before the opening is made into the cranial cavity.

I have never had a case recover from purulent meningitis. I have had many cases recover from localized meningitis and I am fully in accord with the statement just made by Dr. Pierce in this respect.

Dr. Chas. W. Richardson, Washington:—I was surprised at the statement of Dr. Dench that he found 50% of recoveries in cases taken at random. Now these statistics are not worth anything. Dr. Pierce has not reported his case; Dr. Barnhill has not reported his; I haven't reported mine. If a man gets a successful case he goes right into print at

once. Until all the cases are reported, statistics certainly are not worth much. I know of six cases of purulent meningitis that were autopsied and considering the mass of plastic lymph and pus seen over the surface of the brain, and the free pus, it is impossible to conceive how these patients could have recovered. They were all operated on early, some in twelve, some in twenty-four hours. They were all intense infections and they all died. This year I had a case to which I was called in which the mastoid was operated on by a general surgeon, the second day after infection. The patient when I first saw the case had no evidence of cerebral involvement. When I re-operated there was intense infection and the case ran the usual course. Within a month or so I operated on another case. The child had had a suppurating ear for about two weeks, which healed and remained so for about a month, and then meningitis developed. I operated on the mastoid and found quite a little pus. Lumbar puncture was done nevertheless, the child died at the end of eight days. So I am not an enthusiast over operative procedure in purulent meningitis.

There is another side to the question to, and that is the influence on the public. So many of these operations are unfortunate in their outcome. Of course from our standpoint we are justified in operating on these cases because the patient if not operated on will certainly die, but I cannot feel that it is a field that offers much to us in the way of results.

Dr. Emil Gruening, New York:—Last week we had a meeting of the New York Otological Society and a member reported a case of meningitis occuring in a child. He had a lumbar puncture made and found that the fluid drawn was turbid and therefore, he said: "This is a case of meningitis and I will not touch it." This case was admitted to the hospital and died after some weeks. This case was discussed in the Society and the members were opposed to the view of this gentleman.

Enthusiam has no place in science; we have to weigh our evidence and act accordingly. The gentleman who spoke before me says the public doesn't think well of it. What has that to do with it. The public has nothing to do with us. It is a scientific question which we have to solve. Dr. Richardson says look at a case of leptomeningitis that comes to autopsy and see the thick mass of pus there. In cerebro-spinal meningitis at autopsy we see the same purulent (implication), and yet we know that with the Flexner serum and without it many of these cases are cured. Now another question is, can a case that comes to autopsy be compared with a case that doesn't? We have no basis for such a comparison and therefore, these comparisons cannot be made. I am as hopeful as Dr. Randall and think that the future is bright. If we can cure cases of cerebro-spinal meningitis we may eventually cure cases of otitic meningitis with the aid of a serum plus operation if necessary.

Dr. Wendell C. Phillips, New York:—The remarks I had in mind were quite in line with those just made by Dr. Gruening. Results in all operative work and in all lines of science are comparative. If we get good results in one out of ten or twenty, we should consider them brilliant because they are of necessity fatal unless operated on. I think the concensus of opinion of this Society should be that we are favorable to operative interference in all cases of purulent meningitis. It is a field that should be entered with a hope of curing a large percentage of cases, but if we succeed in curing only a few it is well worth while. Those of us who have seen cures are so impressed that we are naturally enthusiastic to go on. One or two that I have seen certainly made me feel that way.

Dr. Edw. B. Dench, New York:—The statistics referred to were not my own, which have been previously reported.

Dr. Arthur B. Duel, New York:—It seems to me it hardly makes any difference whether Dr. Dench's statistics showing 50% of cures are his or not, we should go on record as being

progressive enough to feel that if 50% of cases that would have been fatal have been operated on and cured we should be encouraged to operate on all cases that come under our care. As our experience increases and we become able to differentiate the types of meningitis and understand the kind of operation necessary, our reports of success will be increased.

Dr. B. A. Randall, Philadelphia:—It may be boiled down to this; without operation, cases get well once in a while; with operation, twice in a while.

Dr. Frank B. Sprague, Providence:—It seems to me we should make a distinction somewhere between general purulent meningitis and local meningitis which occurs so frequently with mastoid and middle ear involvement. We have all had cases of localized meningitis relieved by a mastoid operation. Mastoid operation, or even incision of the drum head, has relieved cases where there were pronounced meningeal symptoms. On the other hand the cases of general suppurative meningitis are almost hopeless. At autopsy we see these cases with pus in great clots all over the convexity of the brain and at the base. It would certainly seem almost impossible to do anything with these.

It is questionable whether Flexner's serum which has been referred to ever cures cases of cerebro-spinal meningitis after they reach this advanced purulent stage.

As to the white count, I had a year or two ago a case of purulent meningitis in which the white count was only 11,000 and I was more than surprised when the patient died of meningitis. I had two cases at that time, both of them relieved and apparently getting well after a mastoid operation, and without obvious cause, after two or three weeks the temperature went up, meningeal systoms developed and both patients died.

Dr. E. A. Crockett, Boston, (closing remarks):—In the first place as to the question of death rate I have reported

every case I have operated on since 1904, both fatal and successful. There are only six cases it is true, with recovery of two, but those are all the cases I have operated on in the last five years. So these statistics are accurate so far as my own experience is concerned in these five years. Now my skeptical neighbor here and Dr. Richardson say they do not believe it is possible to cure a case of acute leptomeningitis though they think it is possible to cure a case of localized meningitis. Take the second case I reported, man of 25, with acute otitis six weeks before, mastoiditis two weeks before, who two weeks after operation shows a steady rise in temperature, absolutely without remission—from 101 to 104 or five, with pulse going down from 90 to 50, with well marked Kernig sign and unconsciousness; now I submit that that is a typical clinical picture of diffuse leptomeningitis and not a local meningitis at all. I cannot agree that without operation the man would not have died. After his skull was opened there was pus in the dura, and hernia showing great increase in pressure. Now standing on that case alone I claim that operation alone could have saved the patient.

I attribute the improvement after the operation entirely to early operation and to the continuance of subdural drainage. After the skull cap is filled with pus you probably cannot get the case well, but if you perform the operation early before you have such an accumulation of pus you may be able to pull the patient through and prevent such an accumulation. To do that drainage must be left in for several days. That cannot be accomplished by lumbar puncture alone. The dressings will have to be renewed in the average case once or twice a day as they will be soaked with fluid. I do not claim any priority, but simply wish to bring the matter to your attention.

REPORT OF A LARGE CEREBELLAR ABSCESS OF OTITIC ORIGIN; RECOVERY.

By NORVAL H. PIERCE, M. D., Chicago, Ill.

On February 1, 1909, R. K., female, aged 20, Polish, came to my office complaining of pain in the right mastoid region and occiput. There was right facial paralysis, which followed an earache which began four weeks ago. Patient had been treated by another physician for otitis externa. On examination there was a red, circumscribed swelling on the superior wall which had been excised. There was no swelling or tenderness over mastoid. There appeared to be no pus in the external auditory canal, and the swelling almost completely obscured the view of the tympanic membrane. The pain was excruciating, so much so that I made only a superficial examination, and told her to go at once to the hospital. She could scarcely give an intelligent history of her trouble on account of the severe pain in her head, which had completely prevented sleep for several nights. She constantly shifted the position of her head, resting it first on one hand and then on the other. She did not follow my advice as to the hospital to which she should go, but chose another. On the night of February 5th, Dr. Jacob Frank called Dr. Hugh T. Patrick and myself in consultation. Dr. Patrick's notes follow:

"Mother had cancer; seven years ago patient had earache on the right side, and off and on since, otherwise normal. Four weeks ago pain occurred in the right ear. A physician found an apparent furuncle in the external auditory canal, which he lanced, still the pain continued, situated in the occiput, changing from right to left, and then all over the head. Temperature 99.5°. Right facial paralysis; eyes oscillating prominent; vomiting began nearly

two weeks ago and has continued. Four days ago came to the hospital; since then no fever; temperature rather subnormal. Today neck is rigid. No swelling or tenderness over right mastoid; no reeling. Hearing is very slight in the right ear. Answers slowly; mental hebetude. Mental hebetude was more marked the first couple of days in the hospital; pulse 60; respiration 20; right disc blurred."

If the relatives had endeavored to conceal the fact that there had been a chronic suppuration, it could not have been more difficult to elicit the fact that during a number of years the patient had had a slight discharge from the right ear, but this at length was disclosed and on swabbing the depth of the canal with cotton, a very slight amount of thick, foul-smelling pus could be detected. There was a horizontal nystagmus. I administered the caloric test, using cold water in the right ear. The nystagmus was not increased in the least, while the test applied to the left ear increased it markedly. The nystagmus was toward the sound side. A diagnosis of cerebellar abscess of labyrinthine origin was made, and an immediate operation urged. The relatives refused until the next morning, when, the patient's unconsciousness being quite complete, consent to operation was given. Very little anesthesia was necessary. I began with the usual radical mastoid. The mastoid bone was very dense. The antrum was found to be very small, scarcely larger than a small pea, and was filled with cholesteatoma. The aditus ad antrum was constricted. The tympanic membrane was replaced by scar tissue, which was adherent to the promontory, and only a small portion of the head of the malleus could be found. The external semicircular canal was covered with granulation tissue which, on removal, disclosed a small necrotic slit, with darkened edges. After opening the external semicircular canal, it was found to be filled with granulation tissue, but no free pus. The vestibule was opened and found comparatively normal. A portion of the pyramid from and including the posterior semicircular canal to the upper border of the

sigmoid sinus was removed, and after careful search no fistula leading from the internal ear could be found. There were no adhesions between the dura and the bone, nor granulation tissue. The appearance of the dura, which was exposed for about one centimeter, seemed quite normal. As no leads could be found to guide us in the location of the cerebellar abscess in this region, I decided that the abscess should be drained and the cerebellum exposed at a more favorable place. The aural wound was, thereupon, packed, and an incision made by Dr. Frank that extended from the lower third of the mastoid incision upwards in a curved direction to the superior curved line of the occiput, and down to the inferior curved line about two centimeters from the median line. This flap was turned back. Well down below the center of the space thus denuded, the bone was perforated with mallet and chisel, and the opening enlarged with bone forceps, the dura crucially incised, and a grooved director introduced into the cerebellum in a direction forward, upward, and slightly to the median line. The cerebellum did not appear to be under any great pressure. The grooved director had not penetrated more than part of a centimeter before the abscess cavity was entered. About forty cubic centimeters of a thick odorless pus was evacuated. The finger introduced into the abscess cavity showed that its walls were thickened and of sufficient resistence to prevent complete collapse. A large rubber tube was introduced into the cavity and carried through an incision in the flap, which was made to correspond to the position of the osseous opening. I then returned to the aural wound and completed the toilet there, making a flap of the external auditory canal, partially sewing up the mastoid incision and completely sewing up the occipital.

I will not detain you with a detailed history of the course and after-treatment of the patient; but the next day the patient recognized me and spoke my name. The nystagmus was present, but less marked. On May 5th the wound had entirely healed. The slight incoordination and

paresis of the right arm had all but disappeared. The facial paralysis remains complete, but the patient is able to resume work.

EPICRISIS.

The first point of interest is the difficulty with which the history of a chronic suppurative inflammation of the right ear was elicited. Not a few of these patients pay little or no attention to the very slight discharge that is present, and these are the most dangerous cases. Cerebellar abscesses occur by far most frequently from chronic aural suppurations and are themselves in a large proportion of cases, when first seen, in the manifest stage of a chronic abscess. A division of them into two classes is of practical clinical assistance, namely, those arising from and secondary to thrombosis of the sigmoid sinus, and those arising from labyrinthine invasion. These cover practically all cerebellar abscesses. It was a great help to us, in making a diagnosis, to know that the right static apparatus did not respond to the caloric test. After destruction of the right semi-circular canals the further fact that the nystagmus continued, proved that it was not of labyrinthine origin, but of central. Nystagmus induced by circumscribed disease of the labyrinth is in the early stage, the so-called irritation stage, directed toward the diseased side. After the labyrinthine destruction advances, the nystagmus is directed toward the opposite side, and so continues until the labyrinth is destroyed. Headache is a much more prominent symptom in cerebellar abscess than in abscess of the cerebrum. In this patient a history of ataxia does not appear. On this point nothing certain can be said on account of the clouded intelligence of the patient. It is possible that a hemiparesis of the same side was present before the operation, as it was clearly demonstrable immediately afterwards. The absence of elevation of temperature in this case was a favorable prognostic sign, as temperature in these cases probably

always means involvement of the meninges. The stiff neck, which was present on the night previous to the operation, does not indicate meningeal involvement, but is, rather, merely a pressure symptom. The slow and rhythmic pulse is an especially frequent symptom of abscess of the cerebellum, but shows itself most frequently in the commencement of the disease. Percussion did not elicit sensitiveness in any particular locality. Vomiting is an important symptom in cerebellar abscess. It is most important in those abscesses of labyrinthine origin than in those connected with septic thrombosis of the lateral sinus, inasmuch as the vomiting in the latter class of cases may be due to sepsis. Changes in the fundus of the eye are an accompaniment of abscesses in all portions of the brain substance, and are not of differential diagnostic weight as to the location of the abscess, nor are these changes to be depended on as pathognomonic of intracranial disease. Bezold found in one hundred cases of acute otitis media and empyema of the mastoid that twenty-three showed changes in the fundus, among which were ten cases of uncomplicated empyema of the mastoid. The facial paralysis in these cases may be caused by pressure on the nerve at the point where it enters the internal auditory canal; again, it may be produced by pressure on the pons, or it may be due to necrosis of its walls in the internal ear.

TECHNIC. A word as to the operative technic in these cases. When a cerebellar abscess is of labyrinthine origin, an attempt should always be made to reach it through the place of origin. Fistulas, granulation tissue, and other marks by which we can trace the path of infection from the labyrinth are of the utmost help in aiding us to reach the abscess. If, however, these are not found, I regard it as a sound surgical principle to abandon this route for one through which the abscess may be more readily reached, and when reached much more readily drained. The space in which we have to work, after taking away as much as possible of the posterior surface of the pyramid, is at best very small, and in order to reach the cerebellum our instru-

ments must be bent in our exploratory endeavors. It, furthermore, does not give us sufficient room to fully explore in all directions; the reverse is true when the occipital route is chosen. If we should reach the abscess through the labyrinthine route, our drainage is most unsatisfactory, on account of the smallness of the area precluding the use of a large tube and because the position is not the most dependent. Drainage through the occiput allows us to use a large tube, exploration with the finger, and drainage takes place at the most dependent portion of the abscess, whether the patient lies in the recumbent position or assumes the upright.

Discussion.

Dr. Edw. B. Dench, New York:—As to choosing the best route in all these cases, out of 100 cases cerebellar abscess which one of my assistants has been able to get together for me in a good proportion the drainage was successful. In the case I reported had I explored more thoroughly in front I would have struck the abscess. In one case pus was found in the cerebellum just in front of the sinus. The abscess was opened there and the patient did well for a while and I said if the symptoms returned I would advise a counter opening. This was done and the patient recovered.

Richardson has reported a case of successful through and through drainage. I tried it in one case but the patient died. It depends upon the anatomical structure. If the sinus is far forward it is almost impossible to drain by anterior incision; if it is far back we have space enough to get in and drain a small abscess.

Dr. B. A. Randall, Philadelphia:—We cannot do an aseptic exploration through a septic wound; and unless I have positive local symptoms I want to make an aseptic opening. Where we can do an aseptic operation through a clean wound it is a much safer procedure.

Dr. Wendell C. Phillips, New York:—I had one case that had lateral sinus thrombosis and cerebellar abscess and in this case the inner wall of the sinus was opened and it was easy to enlarge that opening and drain a very large cerebellar abscess. That case recovered and lived some six weeks and then was suddenly taken with what appeared to be meningitis and returned to the hospital and died in 24 hours. The autopsy showed an area of healed abscess and that afterwards there had been a meningeal involvement from which the patient died.

Dr. A. B. Duel, New York:—The serious objection to Dr. Randall's position is that if the exploration is made **through a healthy area**, and the abscess is **found**, then the **drainage** of the abscess **must be through an area that has not been previously exposed to infection.** Ballance makes it a point of importance to go in through an area where **inflammation** has caused a **walling off**, as here the danger of diffuse leptomeningitis is avoided. It has happened in a number of cases I have seen that this very thing has occurred; that, having found the abscess, and having drained it, subsequently there developed a diffuse leptomeningitis from the new area exposed. Mr. Ballance has insisted upon this and advocates the measure, in cases in which there is no imminent danger, to expose the area; to make a crucial incision and pack down the dura and waiting for adhesions to take place before puncturing the brain substance, in search of the abscess.

A point in diagnosis which Dr. Pierce makes is interesting. I think I understood him to say that the first symptom in suppurative labyrinthitis was a lateral nystagmus **toward** the affected side; I have not understood that as being the case. In the cases I have observed when the labyrinth has been invaded marked lateral nystagmus has taken place **away from** the affected side.

Dr. Norval H. Pierce, Chicago, (closing remarks):—Of the two divisions of abscess of the cerebellum, those arising

from the labyrinth and those arising from the sinus, we should adopt the method I have recommended in the former; in the latter it does not make so much difference.

As regards Dr. Duel's remarks I would say that I explicitly stated that we should always endeavor to find the so-called stalk of the abscess, but in finding the leaves it were better to abandon this route and go in from behind. It has a further advantage that I did not mention, that we can explore here in a comparatively aseptic region.

Regarding the remarks about nystagmus, Neuman says that the nystagmus in the early stage of the disease is toward the diseased side, after destruction of the labyrinth begins it is toward the opposite side and so remains until the labyrinth is destroyed.

A REPORT OF TWO CASES OF BRAIN ABSCESS.

By EDWARD BRADFORD DENCH, M. D., New York, N. Y.

The two following cases of tempero-sphenoidal abscess occurred upon my service at the New York Eye and Ear Infirmary during the last year, and present certain features which seem to make them worthy of being reported to this Society.

Case 1. An Italian male, age 29, was admitted to the hospital, with the history of pain in the left ear for about a month. Ten days before admission there was pain and redness behind the ear. For three days prior to admission, the left side of the face had been paralyzed. An examination showed redness and oedema over the tip of the left mastoid, tenderness on pressure over both antrum and tip, and slight tenderness along the course of the internal jugular vein. The external auditory meatus was very much swollen, so that it was impossible to make out any details regarding the condition of the membrana tympani. The canal was filled with a foul-smelling discharge. The temperature was 100°. The left drum membrane was immediately incised, and antiseptic irrigation instituted. On the following day the temperature rose to 101°, the patient was somewhat dull and apathetic, and was immediately operated upon.

The cortex of the mastoid was found to be soft throughout. The antrum was very small, and the middle ear was full of foul pus. The dura was exposed over the entire tegmen antri and tegmen tympani, and was found to be covered with thick granulation tissue. A perforation of considerable size was found passing through the dura into the tempero-sphenoidal lobe, and through this opening about an ounce of foul fluid-pus was evacuated.

The complete radical operation was done, the wound in

the dura enlarged, and a cigarette drain was inserted through the dural opening into the abscess cavity. The ordinary plastic operation upon the meatus was done, the posterior wound was left open, and thoroughly packed with iodoform gauze.

From the time of the operation the patient continued to improve steadily. The amount of pus discharged from the abscess in the tempero-sphenoidal lobe gradually diminished in quantity until ten days after the operation, when all drainage from the abscess cavity was discontinued. Two weeks after the drain had been removed from the abscess cavity in the tempero-sphenoidal lobe, the patient was again anaesthetized, the entire radical cavity was covered with a skin graft and the posterior wound completely closed by sutures. The patient made an uninterrupted recovery. The graft adhered perfectly and the entire operation-cavity was dermatized at the end of about two weeks after the operation. The facial paralysis also entirely disappeared. The patient has been seen a number of times since he was discharged from the hospital, and is in a condition of perfect health.

Case 2. An Italian, age 26, was admitted to the New York Eye and Ear Infirmary, with the history of having been operated upon for a simple mastoiditis, in a neighboring town, three weeks before. For two weeks before he came under my care, the patient had suffered severe pain in the head, night and day. This pain had been so severe as to prevent sleep.

Examination showed the ordinary mastoid wound behind the left ear. The wound seemed to be in good condition, and contained but little pus. The walls of the external auditory meatus were somewhat collapsed. Upon admission to the hospital the temperature was about 101°. On the following day it was normal, and on the third day it rose suddenly to 103½°. The headache had continued steadily since admission. On admission an examination of the blood

showed 15,800 white cells, with a polymorphonuclear count of 56.2%. On the second day after admission, however, the polymorphonuclear percentage had risen to 77.8%, while the leucocyte count remained about the same. Owing to the increased polymorphonuclear percentage, the persistent headache, and the sudden rise in temperature, I decided to operate upon the patient a second time.

The old incision was opened, and it was found that the tip of the mastoid had not been removed. The mastoid cells were completely obliterated, and the lateral sinus was found exposed and covered with granulations. Further exposure of the sinus was made, until normal was encountered. The antrum had not been opened at the former operation. The antrum was found to be small, situated at a lower level than normal, and was full of foul granulation tissue. The tympanic cavity was also found to be full of granulation tissue.

Owing to the extensive tympanic involvement, the complete radical operation was done. The tegmen antri and tegmen tympani were wanting, and an opening was found through the dura in this location. A probe passed through this opening, entered directly into the substance of the tempero-sphenoidal lobe. No pus followed the probe. Apparently, at the preceding operation, the operator had failed to open the antrum, but had perforated the tegmen antri, and dura as well, and had entered the tempero-sphenoidal lobe instead of the antrum. The tegmen antri and tegmen tympani were still further removed until healthy dura was encountered. The opening through the dura was enlarged, and a cigarette drain inserted into the tempero-sphenoidal lobe. The ordinary meato-conchal flap was made, and the posterior wound partly closed with sutures. The ordinary antiseptic dressings were applied. The patient's temperature gradually fell after the operation, until one week after the operation, it was normal. The headache also gradually disappeared. An ophthalmoscopic examination showed that each optic disc was normal. The patient continued to improve for about a week, at the end

of which time he again complained of headache, and a small amount of pus was found, apparently coming from the tempero-sphenoidal lobe. A careful examination revealed the fact that the drain had not been carried to the bottom of the cavity in the tempero-sphenoidal lobe. The drain was carefully replaced, and for a few days the patient was better. Two weeks after the operation the patient still complained of severe headache, and an ophthalmoscopic examination showed a mild choked disc upon both sides, more pronounced upon the left side. Lumbar puncture was done, and considerable opalescent fluid was evacuated from the spinal canal.

Examination of the blood at this time showed a polymorphonuclear percentage of 77%. The blood examinations, previous to this time, after the operation, had not shown any increase in the polymorphonuclear percentage. The dural opening was enlarged by incision, and a larger drain was inserted into the tempero-sphenoidal lobe. From this time on, the patient steadily improved. The headache gradually disappeared, the temperature soon fell to normal, and the patient was up and about the ward. An ophthalmoscopic examination was made from time to time, and although the choked disc never completely disappeared, the appearance of the optic discs was much improved, showing a gradual subsidence of the swelling of the optic papillae. Two months after the operation the sinus leading into the tempero-sphenoidal lobe had entirely closed, and and the tympanic cavity had dermatized over a very large area. Over the tympanic roof, however, at a point which apparently corresponded with the former opening through the dura, a small mass of granulation tissue still persisted. This granulation was removed from time to time with the curette, under strict antiseptic precautions. The external auditory meatus was packed with sterile gauze, and the ear was also kept under a sterile dressing. The posterior wound had by this time almost entirely closed. The patient seemed very well, and from being decidedly lachrymose and apprehensive

about his condition, had become bright and cheerful. Three weeks after, the sinus leading into the tempero-sphenoidal lobe had completely closed. The small area of granulation tissue still persisting was cauterized with a fused bead of nitrate of silver. This was done under strictly antiseptic precautions. This same evening the patient complained of severe headache, and the temperature rose to 100½°. The differential blood count, on the following day, showed a polymorphonuclear percentage of 55.6%. Two days later the temperature rose to 103°, and the polymorphonuclear percentage was 80.4%. The patient complained of severe headache, and also of great pain in the back as well as in the lower extremities. A lumbar puncture at this time, evacuated a cerebro-spinal fluid containing a little blood and a large amount of pus. No germs were found in the smears made from the sediment.

The patient's condition improved somewhat after the lumbar puncture, the pains in the legs became less severe, and the headache less pronounced. The temperature fluctuated between normal and 102°. An examination of the spinal fluid, by Noguchi's test, gave a decided reaction for syphilis.

At this time, the patient was seen in consultation, by a prominent neurologist, who made a tentative diagnosis of "cerebro-spinal syphilis." The patient was then given bichloride of mercury, hypodermatically, in fairly large doses. This medication seemed to exert no influence whatever upon the symptoms. An ophthalmoscopic examination, during this relapse, showed that the optic neuritis had returned, well marked choked disc being present upon both sides.

The patient steadily grew worse, all the symptoms of meningitis gradually appeared, and he became unconscious. An exploratory operation was performed upon the left tempero-sphenoidal lobe, the old wound being opened, and the tempero-sphenoidal lobe being explored as nearly as possible along the old operative tract. The descending cornu of the lateral ventricle was opened and drained. The

patient, however, gradually became worse and died about twenty-four hours after ventricular drainage.

An examination of the brain, **post-mortem**, revealed a sero-purulent meningitis. The old abscess cavity which had been drained, was found. A second spot of softening was discovered at the upper extremity of the fissure of Sylvius. This second spot was evidently the direct cause of the purulent meningitis which resulted in the fatal termination. The pituitary body was of a dirty color, and was exceedingly soft. Upon opening the left sphenoidal sinus it was found to be filled with a muco-purulent mass, loaded with mixed micro-organisms.

It is a question whether the fatal meningitis developed from this inflammatory process within the sphenoidal sinus, or whether it spread directly from the old abscess in the tempero-sphenoidal lobe. It was the opinion of the pathologist that the meningitis was due to an extension of the inflammatory process from the old abscess, although it seemed to him possible that the meningitis might have developed from the empyema of the sphenoidal sinus.

The case is most interesting, in that in this patient we had a tempero-sphenoidal abscess which had, apparently, been successfully evacuated, and the patient was practically cured. The cerebro-spinal symptoms which immediately preceded the fatal termination, developed immediately after the cauterization of the exuberant granulation in the tympanic cavity with the fused bead of silver nitrate. Whether this cauterization was the direct cause of death, or whether the appearance of the symptoms immediately after this slight operation was a coincidence, is, of course, only a matter of conjecture. I believe, however, from my experience in this case, and in one or two other cases, that it is exceedingly unwise to use any chemical caustic whenever the meninges are exposed.

The case is also interesting in that it shows the temporary beneficial effects which may follow lumbar puncture. The first lumbar puncture, performed soon after the evacuation

of the purulent focus in the tempero-sphenoidal lobe, was followed by very beneficial results. The patient, at that time, was apparently suffering from a serous meninigitis, and the relief of the intracranial pressure by lumbar puncture and incision of the dura was sufficient to cause a subsidence of all his symptoms.

Further, the case is interesting in demonstrating that, no matter how good the immediate results may be, following evacuation of a brain abscess, the patient can never be considered cured until several months have elapsed after the operation.

Discussion.

Dr. Dench asked for an expression from some member as to what was thought of the nitrate of silver cauterization.

Dr. J. F. Barnhill, Indianapolis:—Were these granulations sprouting down into the mastoid wound? I have cauterized such wounds extensively without bad results and also extrusion of brain substance in hernia without harm.

Dr. J. F. McKernon, New York:—I have used it in the strength of 480 grains to the ounce and had good recovery. I have used it several times with no bad results.

Dr. Wendell C. Phillips, New York:—I do not believe it had the slightest influence on the course of the disease.

Dr. Charles W. Richardson, Washington:—It is an aseptic agent and I do not believe it could possibly have caused the death.

Dr. Edward B. Dench, New York, (closing remarks):—My reason for bringing the matter up was that in one case of

drainage of the lateral ventricle which lived for over three months I used nitrate of silver on the hernia and 24 hours later the patient died. In another case where I had done a previous mastoid operation, I cauterized a small patch over the mouth of the Eustachian tube and she developed meningitis. Then following this case this third one occurred. As to Dr. Barnhill's question, these granulations were apparently not connected with the dura. It was three weeks after the drain had been taken out before this cauterization was done. It was thoroughly shut off. A meningitis might be lighted up by suppuration in the sphenoidal sinus. What the gentlemen say, however, relieves my mind considerably.

A REVIEW OF SOME RECENT THEORIES OF THE LABYRINTH.

By PERCY FRIDENBERG, M. D., New York, N. Y.

When the investigations of Breuer Mach and Crum Brown and their interpretation of the older data seemed to have definitely established a duality of function for the structures of the inner ear and to have proven that the non-acoustic labyrinth was concerned mainly with equilibration and sense of rotation, when the possibility of an acoustic function residing in the ampullæ or in the maculæ was finally excluded, a promise was given of a rational and uniform basis of explanation for the varied data of clinic and laboratory. The exclusion of the acoustic function and the apparent narrowing of the problem to the question of equilibrium has not made matters less abstruse or less complicated. This is indicated most strikingly by the fact that we are not even in complete accord as to the definitions—the very tools of scientific thought—of such general and fundamental phenomena as vertigo and nystagmus.* The inherent difficulties are based on the fact that the sense of equilibrium cannot be voluntarily excluded, like sight, touch, and others, for the purposes of separate observation; is not externalized, and has no local signs by which it can be compared with other perceptive functions, and is usually exercised almost entirely sub-consciously. Again, anomalies of this function are attended by such marked alterations of attention, disturbances of consciousness, by such decided irregularities in the functions of the other sensory organs, that both subjective and objective studies are rendered very

*(Note. Definition is here taken not in its concrete etymological sense of a label for recognition, but in the general methological aspect, so important for philosophical analysis, of a delimitation in terms of a fundamental theory.)

difficult. Finally, we must consider that this special sense of balance is so intimately bound up with impressions derived from and regulated by other sensory organs, notably touch and sight, including the many and varied forms of the latter such as muscle, pressure, temperature, so much a part of what we may call our instinctive and immemorial general consciousness, that it is impossible to separate it completely from the latter, even theoretically, and thus subject it to scientific analysis.

We accept, more as a working hypothesis than as a finished theory, the idea of the nerve terminals in the ampullae of the semi-circular canals serving on a hydrodynamic basis as sense organs for perception of subjective motion, with the maculae as static indicators of position and inclination and the entire non-acoustic labyrinth as an important, but by no means the sole, factor in muscle tonus. As to the details of this function, however, there is marked variance of opinion, extending not only to the mechanism, the adequate stimuli*, and the relations to the central nervous system, but above all as to the interpretation of many apparently simple phenomena, normal and pathological, and the correlation with other sense organs and with consciousness as a whole. There is not a single theory which has not been attacked, defended, explained, and rejected to be once more rehabilitated on the basis of the very data which were originally adduced in its support, and the study of the literature and of such a complete survey of the field as that of v. Stein reminds us of a forensic struggle with objections, exceptions, overrulings, and appeals which on many points have not yet been settled by a court of last resort.

Adequate Stimuli. The physiological irritation of the ampulla is supplied by head rotation, that of the maculae, by gravity. As in all other sensory fields this adequate stimulus can be supplanted, experimentally or pathologically by various forms of mechanical irritation such as heat and cold, electricity, pressure, traction, acidity, or the finer

* According to Breuer-Mach.

and less tangible factors present in local inflammation and tissue change. The resultant function is naturally analogous, while it may vary quantitatively. This is absolutely paralleled by sensations of light due to compression of the globe or, even after removal of this end organ, of the trunk of the optic nerve; to sensations in amputated extremities due to pressure on the amputation stump, and so on. As careful an observer as v. Stein seems to have overlooked this well known fact. In criticising Ewald's experiments on doves which supported the views of Haller and of Johannes Mueller that the trunk of the auditory nerve, which does not become atrophic after extirpation of the labyrinth, may on excitation cause sensations of sound, he says: "If we follow this path we shall some day reach the conclusion that the entire eye-ball is superfluous for the perception of light."

In a general way we may say that theories of function of the non-acoustic labyrinth differ, not so much in physiological and mechanical data, as in the philosophic or metaphysical application of these facts to different functions, their correlation and causal relation, their significance for the attitude, subjective and objective, of the individual, and finally in the interpretation of their purpose. From the wide range and multitude I have chosen for a brief review, one or two which are interesting as examples of the extremes which are possible in the strictly logical and scientific consideration of this subject; on the one hand, the hypothesis of Hoegyes which limits the function of the labyrinth to oculo-motor impulses, and on the other, that of v. Cyon who sees in it nothing less comprehensive and vast than our entire conception of time and space, based on ideas of number and direction, and explaining their evolution in the disciplines of arithmetic and geometry.

v. Hoegyes (1880) demonstrated that motions of the eye could be elicited directly by irritation, not only of the labyrinth, but of a series of cerebral centres. Rotation experiments showed that these associated involuntary and bila-

teral motions could still be produced after the section of the optic nerve, removal of the cerebral hemispheres, or section of the medulla below the central nucleus of the auditory nerve; the last procedure causing bilateral nystagmus. The movements do disappear, however, after destruction of both membranous labyrinths, section of the acousticus, and other auditory centres, showing that the centre for this reaction-sphere was located between the corpora quadrigemina and the central nucleus of the auditory nerve, and was in direct connection with labyrinth and eye. The entire complex is designated by Hoegyes as the associated nerve-apparatus for eye motions. It is bilaterally arranged in such a way that homonymous deviation of both eyes is induced by homonymous ampullae, while the antagonists in either eye are innervated from opposite sides. (Abduction by homonymous externa, adduction by heteronymous external, upward motion by homonymous superior, downward motion by heteronymous posterior, canal, and so on). Under normal conditions, with the eye at rest, there is a constant reflex from the labyrinth to the ocular muscles, so that the eye is in a state of unstable equilibrium. Any stimulus causes a deviation of the eyes and destroys this equilibrium for a moment. Destruction of the cerebral centre or of either arc of the reflex causes stable equilibrium of both eyes and deprives them of the function of associated movements. This mechanism, as well as the tonic and associative regulation from the labyrinth, is congenital, so that the ampullae are merely the last link in the chain of the oculo-motor control. Section of the centripetal arc in the acoustic nerve is invariably followed by loss of compensatory eye motions. Rabbits blindfolded or deprived of sight by section of the optic nerves show on passive rotation the same disturbances of equilibrium as seeing animals, as indicated by compensatory motions of head, body, and extremities. Hoegyes concludes from this observation that the disturbances of motion are directly dependent on the labyrinth, and are not secondary to visual impressions. Baginsky takes exception to this

theory on anatomic grounds. Hoegyes postulates 12 motor nerves for the various ocular muscles, whereas the oculomotor nerve supplies 4 of the 6 of each eye; the other two, superior oblique and external rectus being supplied respectively by the trochlearis and by the abducens. (I confess my inability to see the force of this objection. Hoegyes expressly mentions the participation of the 3rd, 4th, and 6th pair in his hypothetical mechanism and the number of individual muscles is as immaterial as that of terminal motor nerves, if we consider the factor of regional or functional innervation and not that of each motor end-organ.) Again, the 6 ampullae have in all only 6 cristae, the maculae 2 on either side; 10 in all instead of the requisite 12. (Here again Baginsky seems to have overlooked the text of Hoegyes' communication which considers only the ampullae, not the vestibular maculae.) These numerical discrepancies may be only apparent. More serious objections are supplied by physiological experiment. Thus, Flourens, and later Czermak, and Vulpian, noted that the occurrence of vertigo was an important link in the causation of irregular, so-called, compensatory movements of head and body, as well as of the vomiting.

Goltz then showed that the vertigo depended on the change in the position of the head; fixation inhibiting the anomalies above mentioned, while an abnormal head position caused marked in-co-ordination. Solucha and v. Cyon went a step further and inferred that the disturbance of equilibrium was not directly dependent on the changed position of the head but on the alteration in conceptions of space-position and distance of surrounding objects. Thus, a dove in which diplopia had been artificially induced by prisms, showed exactly the same disturbances, ring movements and pendulum motions of the head, as are observed after section of the semicircular canals. v. Cyon starts from the fundamental hypothesis that the semicircular canals serve, directly, to inform us of the position of the head, and this, indirectly, regulates the preservation of balance. He discards the

Breuer-Mach theory on mechanical as well as physiological grounds, in accord with Delage. The canals are capillary tubes of so fine a calibre that no currents can possibly arise on account of the high specific gravity of the endolymph and the resistence of the walls and friction of the various layers of fluid. The pressure theory (Mach) requires a certain duration of the sensations caused by momentary pressure which is exerted only at the beginning (or end) of a head rotation. After-sensations on standing still subsequent to rotation cannot possibly be explained in this way as Mach attempts to do, by assuming that the sensation outlasts the momentary pressure, as in this case two similar motions of like speed but of unequal duration would give us exactly the same sensation, provided only that they lasted long enough to produce the initial stress.

Anatomical Objections. Furthermore, the semicircular canals are not regular segments of a circle; on the contrary, in almost all animals they describe very complicated curves and bends both along and across the principal axis. In man, the superior canal is perfectly straight where it enters the ampulla. An adequate sensation of rotation in the horizontal canal is possible only if the wall of the ampulla lies in a continuation of the arc formed by the canal. This is not the case, however; the ampullar wall with the crista lies on the side opposite to the convexity of the canal, and is almost exactly parallel with the median line of the body. The planes of the canals are not even parallel to the axis of head rotation, and their position in relation to the centre of head rotation is not suited to the required or assumed function.

Section of a semicircular canal causes no currents whatsoever. The phenomena following this laboratory experiment can be explained more rationally by injury to nerves which destroys the normal inhibitory and regulatory function. Galvanic, thermal, and even rotational stimuli act similarly.

Negative observations. All the endolymph may escape, the canals may dry out, or be filled with gelatine or compressed by laminaria bougies (Ewald) wihout any reaction.

Among v. Cyon's objections are the following: A static theory of the labyrinth excludes all acoustic function, but there is not a single observation on record which proves the nonparticipation of the vestibule and canals in sensation of sound. Comparative anatomy does not support the theory; the static organs are as variable in position and direction as they are in size, and animals without semicircular canals have the faculty of rotation in all directions. In many lower animals the otoliths are in constant oscillatory motion, by means of cilia, so that stimulation by gravity or change of direction and a consequent regulation of body position is out of the question. Clinical study of cases of astereognosis show that the sense of position and direction of various parts of the body may be lost without involvement of the static organ.

v. Cyon's teleogical objections to the Breuer-Mach theory are based on the uselessness of a special sense organ for rotation and rotational vertigo. Labyrinths are found in animals which never turn. Frogs do not waltz except on the turn tables of laboratories, and zoological text books have little to tell us of the dances of lampreys and sharks. Man himself moves forward only, under normal conditions*. The rope dancer according to this theory balances by means of static and rotational sensations which are caused by alterations in the position of the head, but as a matter of fact, the most striking phenomenon of balancing feats is the absolute steadiness and rigidity of the head and neck. Even the eyes are kept immovably fixed on the end of the tight rope, as visual vertigo is the greatest and imminent danger. We note the same instinctive steadying of the head and gaze in walking a narrow path along a preci-

* Manege motions and rotations about a vertical axis are merely continuous motions toward the right or left. What is the sense of a special sense for turning when our general sense of motions in space directions is quite sufficient for this purpose.

pice. (The steadying of the head in equilibration might be very simply explained as a natural avoidance of voluntary inclination so as to allow gravity full scope and so prevent false interpretation of the signals coming from the labyrinth.—P. H. F.)

Rapid and exact co-ordination of motion is essential in bicycling, and above all in fencing, in which the head is kept quite still. The rapid interchange of thrust, parry and counter depends on visual and tactile impressions.

Sensations of speed and acceleration depend only partly on labyrinthine stimuli. They are largely a result of, conscious or unconscious and often faulty, judgment. A horse with a short, quick action appears to move more rapidly than a long legged animal. Twenty miles an hour in a train seems slow. In a sleigh moving at the same rate we think we are going at enormous speed. Visual impressions also play a part. In traversing a solitary plain, where there are few objects by which to note our progress, it appears comparatively slow. In a row boat or sail boat we seem to move faster than in a steamer on account of the constant sensations of motion and slight equilibrational shocks in the former mode of progress. In tobogganing, shooting the chutes, and so on, we often have no sense of downward motion at all, but a feeling of rushing through the air with a slight but pleasurably intoxication (v. Cyon) and a feeling of lightness.

Objections based on physiological psychology. If motion in a curve produces sensations of turning and consequent vertigo we should be constantly subjected to this uncomfortable disturbance in railway travel, in driving, or even in walking. Yet we may turn rapidly and repeatedly, as in waltzing, without a trace of such sensations.

Biological objections. Animals with only two canals (lampreys) do not show any disturbance of equilibrium. They merely have a limited sense of direction, and can move only forward and backward, to the right or left, but

not up or down. These animals have no cochlea and are devoid of all sense of hearing. The otic vesicle is disadvantageously placed for hearing, being enclosed in a cartilage capsule with but one opening (for the nerve) and covered with a thick layer of muscles. Steiner explained the limited motility of lampreys by their lack of pectoral fins. v. Cyon thinks this goes to prove his views, as such fins would be of no use to an animal without conceptions of vertical direction. Dancing mice, the waltzing mice of Japan, similarly have excellent powers of balance and turn in one direction at top speed for a long time without appearing to lose balance or to become dizzy. They have but one pair of canals, the vertical superior canals, and turn about the axis of this canal. They cannot move straight forward or backward as they lack the corresponding conceptions of direction. The mice do not waltz when blindfolded. They then act like animals deprived of all semicircular canals, indicating that visual and tactile sensations under physiological conditions are depended on to supply part of the absent labyrinthine function. These animals, too, are free from rotational vertigo. If semicircular canals serve to indicate head rotation, how is it that we find them well developed in animals, like fishes and frogs, which have scarcely any independent motion of the head, and rarely perform rotation movements.

The rotation of dancing mice in the axis of the defective horizontal canals indicates to v. Cyon a direct loss of the normal inhibitory action of this pair, and an overflow of innervational stimuli into the paths for rotation, by preference.

The Psycho-physiological nature of vertigo. The sensation has been best described as a feeling that visible space is turning within another, unknown, space. Purkinje showed that the axis of this apparent rotation changes with the axis of rotation of the head. The mechanical effect of rotation on the entire brain matter and blood currents causes a confusion, especially of visual impressions, and the movements of the eyes in attempt to gain support by fixation accentuates this disharmony of sensation.

The Sensation of Verticality. Breuer and Mach explain this innate sense as depending on gravity. In going around a curve the resultant of centrifugal force and terrestrial attraction cause an apparent subjective inclination which causes a false sensation of verticality in external objects, such as houses, telegraph poles, etc., on the outer side of the curve. v. Cyon shows that this observation is faulty. In the first place, everyone knows that railway curves, running tracks, circus rings, and so on, are banked, so there is an actual objective inclination of the observer. The false perception of the vertical is caused by this inclination aided by the inclination of doors and windows in a train. If we lean out of the car, or merely look at objects through an opera glass so as to exclude the inclined picture frame, the objects appear vertical. The hypothetical inclination of the corneal meridian in compensation of external inclination has never been seen. In gravity railways this delusion occurs only when the floor of the cars is inclined. In cars with banked rows of seats there is absolutely no trace of it. The entire deception is accordingly, an error in judgment, not in perception. Here there is of course no rotation at all. The inclination of the body in skating, bicycling, or riding around a ring, is similarly and incorrectly explained by Breuer-Mach as a result of faulty perception of the vertical, whereas in fact it is simply due to the natural inward leaning to keep balance and to neutralize centrifugal force. Horses are especially trained to gallop on the right shoulder so that the inner side of the body takes the longer steps and there is less danger of striking the wall of the ring in rounding corners. The inclination of the horse's head to the left facilitates the free stride and has nothing to do with perceptions of the vertical, as in a trot, no matter how fast, the head is held straight on curves as in the straight. The inclination of the head often precedes the turn. Breuer's studies of his own sensations in a revolving chair are also vitiated by his having overlooked the actual inclination caused by centrifugal force.

Sensations of turning on trains are very vague unless supported and confirmed by visual impressions.

Objections to Experiments Based on Rotation. If the rotational theory is correct, no effect should follow rotation after the labyrinth has been disconnected by section of the acoustic nerves. v. Cyon showed that a rabbit rotated under these conditions presents exactly the same phenomena as normal animals (Steiner, Baginsky, Bechterew.) Breuer himself observed the phenomena of so-called rotational vertigo after extirpation of both labyrinths. How can these organs, then, have as a function the sensory perception of rotational vertigo or of rotation?*

The reaction of animals to rotation must be interpreted with caution. Human beings, who understand the nature of the changes of position act quite differently from centrifuged animals, whose every movement can be explained as an attempt to escape or to resist the forced change of position. We have no right to consider these movements as indicative of sensations of rotation or of vertigo. The movements clearly indicate an attempt to counteract centrifugal force, to get a better hold on the turn table, to minimize the effect of rotation, or, finally, in the case of nystagmus, to find fixational support in the visual field.

All these sensations and movements are explained by Breuer as compensatory and intended to determine the angle of rotation described by the head.

False Conclusions. If head rotation stimulates the semicircular canals and this, in turn, produces rotational vertigo, animals, including man, should be subject to constant dizziness, as the mechanism in question would act as a perpetual motion, for irritation of the canals admittedly causes head rotation. That head rotation does not stimulate the semicircular canals seems to be shown clearly by the rapid,

*Delage and Aubert admit that this is a valid objection. The observation of Breuer that blindfolding prevents the appearance of the rotational phenomena merely shows that optical impressions may cause it, but by no means invalidate v. Cyon's conclusion that the labyrinth does not.

irregular, yet accurate flight of birds, particularly gulls. If they have any rotational vertigo it does no appear, as these birds can snap up food on the wing with the greatest ease and precision.

"Rotation" reactions can be elicited in a dove by moving it rapidly to the right or left without any turning whatever.

Visual Impressions as a Factor in Rotation Reactions. Blindfolding diminishes or abolishes most of the reactions. If a rabbit is laid on its back in the turn table a similar result is noted which depends on the exclusion of motion from the animal's field of vision.

Nystagmus of head and eyes is a purely visual phenomenon. On turning through a small angle animals try to keep in touch (v. Cyon) with the retinal image. In man there is no resistence to experimental rotation, and head and eyes follow the turning as do those of animals in voluntary rotation.

Animals which have been repeatedly rotated get used to it and no longer turn the head but rotate against the turn table, or point the head towards the centre. Rabbits sometimes close their eyes.

Rotation in the dark, of animals or human beings, is much less apt to cause nystagmus and vertigo, which can however be elicited immediately if they are then exposed to light.

Turtles show the usual reactions, nystagmus and so on, when rotated, but if turned while the head is drawn back into the shell, there is no reaction whatever, on account of the absence of visual disturbances.

Observations on Deaf Mutes. According to v. Cyon, as visual vertigo depends on discrepancy between visible space and labyrinthine preceptions, deaf mutes should be free from this form of vertigo as well as free from sea sickness and nystagmus, either rotational or mechanical. This assumption has been verified. Their labyrinthine defect also makes it impossible to consider eye motions in rotation as compensatory for labyrinthine irritation, as inferred by

Kreidl, Delage, and Aubert. Again, they are not subject to delusions of verticality, as their visual perceptions are not compared to labyrinthine sensations in rotation or inclination. Their ideas of space have not been studied carefully, but v. Cyon believes that they must be imperfect. Their disorientation may be explained quite simply by the loss of acoustic stimuli which supply normally the source of direction perceptions and reactions. Exclusion of other correcting senses, especially vision, as in diving, is followed by a natural loss of sense of direction but not by disturbance of equilibrium. Co-ordination and balance are not necessarily defective in deaf mutes, as is shown by their ability to perform various delicate motor functions in gymnasium and play ground.

Galvanic Vertigo. The phenomena have not been uniformly interpreted, even by supporters of the hydro-dynamic theory, and even the experimental data are not uniform or unequivocal. It is quite possible that not only the nerve terminals and the ampullae but other organs, notably parts of the central nervous system, are simultaneously affected by galvanic currents running through the head from side to side. These factors must be excluded if we wish to get exact results.

Tonus Labyrinth Theory of Ewald. Flourens and Chevreul noted that the absence of the semicircular canals, and not their presence, was the cause of loss of inhibition of various innervational stimuli. v. Cyon analyses this function and concludes that it consists in preventing the continuous leakage of innervation stored up in motor centres of the brain, cerebellum, and medulla, besides regulating the quantity and duration of innervation communicated to various muscles. Ewald overlooked the striking fact that the action of the body muscles is enormously increased just after section of the semicircular canals, although he himself notes the fierce struggles of the experimentation animals which,

ordinarily, are easily mastered. The disturbances in gait of pigeons are spastic not paralytic, and careful measurements fail to show any lengthening, as muscle tests fail to reveal any diminution in contractility or tone. Furthermore, granting Ewald's hypothesis, we cannot speak of the mechanism as a sensory organ. As Loeb has observed, we might just as well speak of a tonus retina, tonus posterior column, or tonus tact. Since 1900, Ewald has abandoned his tonus theory and considers the vestibular apparatus as an organ for perception of space. v. Cyon. l. c. p. 154.)

Evolution of Labyrinthine Function and Mechanism. In very low forms of animal life we find, as the simplest form of acoustic organ, an otolith in a vesicle upon the wall of which the terminal filaments of a nerve ramify. It is generally assumed that these otoliths act as resonators and act as amplifiers of the sound vibrations communicated from the surrounding medium. We cannot decide, a priori, whether this mechanism is intended for hearing or for the recognition of body movements, as the reactions of the organism to sound vibrations could be as easily explained on either hypothesis. If we consider the importance for these lower animals, particularly for the marine forms, of an exact appreciation of passive changes in body position such as are almost constantly being brought about by various currents of water, and note how the otic vesicle appear at a time when the rudiment of the eye is as yet only represented by a dot of pigment, we may well assume that the primitive function, the first activity of this manometer vesicle in registering the shocks communicated to the otolith, serves to sense the movements of the organism. In higher animals there is a division of function into perception of position and direction of external sound-producing objects, and a recognition of the subjective, internal variations of motion and rhythm. The more complicated mechanism of the entire labyrinth merely corresponds to this division of physiological labor. For animals, as well as for aboriginal man, it is an imperative necessity to recognize the cause and

distance of any sound-producing object, for purposes of defense as well as of attack. The direction having been perceived, there is an immediate attempt to approach the object in question. In the course of such reactions the organism learns how to carry out the movements which will serve its purpose, and in this way, in the course of time, the various reflex relations are established, developed, and organized, which functionally connect the ampullar nerves with the various motor spheres, and are most perfectly expressed in the mechanism of control. In the interests of self-preservation this mechanism finally functionates automatically and without the necessary intervention of conscious will.

Conceptions of Space and Time. According to v. Cyon, Kant, who explicitly admits the prime significance of experience, thought of some external sense as a basis for our conceptions of space, but as the physiology of his time gave no clue to the organ in question, he was obliged to have recourse to a generality, the "property (Eigenschaft) of mentality" as the fundament of space perceptions. Now, that we can see rapidity, and hear rhythm and tact of tones, a more exact analysis is possible. Space was a necessary a priori assumption which underlies all external concepts and which they presuppose.

The solution of the problem of time and space gives us direct and deep insight into the mechanism of certain psychical processes, notably those which as Vierordt says, serve to distinguish the subjective ego from objects in the external world and to afford knowledge of its time and space relations to them. The system of ideal co-ordinates constructed with the aid of the three direction-perceptions of the semicircular canals, whose zero point coincides with subjective consciousness, and on which we mentally project and externalize all the special sensations, gives us a representational conception of all the important psychical phenomena.

The apodictic character, the innate necessity of truth, recognized as inherent in arithmetic and geometric axioms, is

not contradicted, but on the contrary, supported by the discovery of an anatomic and physiological basis in definite sensory impressions and resulting conceptions. Such a basis could be given only by the century of experimentation which has supplanted those of "eternally sterile" metaphysics.

Johannes Mueller gave to the hypothesis of Kant a natural science form. The conception of time cannot be evolved, but, like that of space, is itself the necessary premise and point of view for all sensory concepts. We sense only that portion of ourselves which is under functional stimulation and project it into the corresponding part of the external world. In the demonstration of this theory investigators limited themselves almost exclusively to the organ of vision and to visual space, whereas the solution of the problem lay in a sixth sense, that of space. This most elementary and widespread of all senses was neglected because its function is continuous, unvaried, and serves to inform us only of three invariable attributes of infinite space. The sensations it produces are those of the three cardinal directions, sagittal, horizonal, and vertical. These sensations are subconscious and in the course of racial and individual life have become instinctive. Sensations of motion and innervation cannot explain them as they are often vague and as they precede the latter and definite sensations or conceptions of direction must be present before any motion at all can be intended.

The space problem for mathematicians and philosophers was formulated in the question why the human mind is obliged to refer all sensory impressions to a geometrical form of tri-dimensional space.

Muscle Sense. E. H. Weber was the first to show that we have no immediate sense of muscular innervation and that we merely perceive the results of such innervation as expressed in varying degrees of contraction. Sense of space is a general sense as distinguished from the traditional five special senses. E. Hering postulated three specific

sensations of direction in the retina in place of the hypothetical circles of tactile sense which Weber had assumed as a physiological basis of the sense of space. Vierordt, too, assumed that the sense of time was also a general mathematical sense, and was the first to recognize in the labyrinth of the ear the most appropriate organ for experiments on measurement of time values and conceptions.

Duality of acoustic function of labyrinth psychologically and purposively depends on its excitation by external and internal stimuli which are respectively discontinuous, occasional, and constant, thus giving us conceptions of the distance and direction of sound producing objects in the outer world and on the other hand, allowing us to form accurate concepts of internal processes both sensory and motor, and serving to regulate, inhibit, excite and modify the innervation of various loco motor and sense organs. The instinctive knowledge of abstract number which is essential for such a function depends on a peripheral sense organ which is nothing more nor less than the cochlea.

Mechanism of Space Perception. (v. Cyon.) The planes of the semicircular canals form a physiological system of coordinates on which our conceptions of space depend. Illusions as to our position in space caused by inclination of the head are due to the altered position of the planes of the canals and consequent false estimate of this system of coordinates. These alterations and delusions of direction are easily influenced by various stimuli, such as light, sound, especially music, and by will-stimulus. Sound waves supply the adequate stimulus for the semicircular canals. Objections to v. Cyon's theory of the labyrinth as the sense organ, and the vestibular branch of the 8th as the nerve, of space, have been raised by Lussana, Nagel, and others. Among them we may cite the following: Patients with Menière's disease do not evince any disturbance of orientation or of space sense. Total extirpation of the labyrinth causes no disturbance of motion. Perception of space and of direction

of sound are not simple sensory phenomena; they are ideas, concepts, intellectual process. An animal deprived of its cerebrum has no intelligence and consequently no conception of space, but lesions of the labyrinth still produce characteristic motor disturbances. The latter, accordingly, cannot depend on cerebral function, which has, on the contrary, an inhibiting action.

Objections to nativistic theories of space sense. According to Mueller and Hering, various points of the retina can induce sensations of space as well as of color. Sensations of height and width (latitude and longitude) which combine to characterize the position of an object in space by means of its position in the visual field are the same for corresponding retinal points in the two eyes. A third sensation of extent, of a special nature, that of depth, has an equal value but opposite signs (+ and —) at corresponding (identical) retinal points and with similar signs at symmetrical points. This faculty depends on an inherited mechanism (Hering) or on a direct knowledge by our mind of the extent of the retina (J. Mueller), which is also inherited. The fundamental objection to this theory is the impossibility of a complete representation of space being caused by a single nerve irritation without any previous experience (Helmholtz). The laws of general physiology and particularly that of specific energy are not to be reconciled with the mediation, by a single fibre, of two completely incongruous sensations, that of light or color and that of space.

Objections to Empiristic Theories. According to Helmholtz, our ideas of space are the result of experience. Sensory impressions are, for our consciousness, symbols whose meaning we learn to understand by means of our intellect. The symbols, signs, obtained by vision, differ in intensity and quality (luminosity and color) and in the location of the point of the retina at which they are incited. This produces a local sign, so called. The local signs of sensations of the right eye are regularly distinct from those of the

left. Furthermore, we feel the degree of contraction innervation of the ocular muscles. Our ideas of space do not necessarily depend on visual sensations as they alone may be developed quite regularly and completely in the congenitally blind by means of tactile sensations. The concepts of location and order of objects in space is gradually formed on a basis of experience by means of association of ideas, through judgment and habit.

The main objection to the agency of muscle-sense plus local sign as indicating space is the impossibility of understanding how such sensations could serve to develop sensations or conceptions of a space of three dimensions. Oculomotor as well as tactile sensations are merely the sensations which indicate what muscles we have to employ to bring us into fancied and real contact respectively with a certain external object. In all these sensations there is not a trace of any relation to space, and still less any representation of space itself. The addition of certain arbitrary local signs to our sense concepts, which themselves have no relation to space representation, can hardly influence our psychical processes to localize sensory impressions, and to arrange them in a regular geometrical system of three dimensions. Why does not the intellect conceive of a space of 4, 5, or n-dimensions, at will, which we cannot even imagine on account of our present habitual space concepts? Again, how does the mind allot to each sensation its definite place in relation to the objective stimulus which elicited it? The latter question alone can be answered by the theory of local signs. The first question is metaphysical. We might as well ask why we do not hear colors and see tones. v. Cyon believes that all sensory organic percepts may be referred to a tri-dimensional space with the aid of local signs, as soon as we have an organ which allows us to perceive the three directions of space. On this basis, space ceases to be a pre-existing "point of view," and becomes a mental abstraction depending on sensory concepts and specific impressions of peripheral sense organs, just like color, tone, and so on.

Abstract space is tri-dimensional because objective space is perceived with an organ which is limited to three space impressions. Auditory as well as visual, tactile as well as muscular, sensations are all referred to such an organ in man.

Motion sense cannot give us an idea of direction, as the latter must precede conscious and purposive motion. Eye motions can be excluded, as in momentary instantaneous exposure, without interfering with direction sense. Moreover, we have no definite sense of muscle innervation, but merely a recognition of the result of contraction with the accompanying tactile sensations, and so on, with the usual errors of judgment. Visual vertigo is not a result of eye motions, alone. Many forms of nystagmus are free from this complication. Vertigo due to alcohol is diminished, that due to sea sickness increased, by opening the eyes. In the one case, the sensorium is steadied, as it were, by motionless objects, while in the other the constant irregular motion of the entire visible field increases subjective confusion quite independently of motion of the ship. (This is borne out by the persistence of vertigo in sensitive persons after getting on land, in the form of a continuation of apparent motion of external objects.—P. H. F.) The disturbance of brain masses by irregular motion may be excluded without inhibiting vertigo, as in the form due to prisms, cylinders, or even over-correcting spherical lenses. Rotational vertigo as well as the cerebellar form is increased by closing the eyes. In short, any lack of correspondence between visible space and our habitual concepts causes vertigo, whether it is due to eye motion, optical disturbances, labyrinthine disease, or cerebral lesion.

Operations on the canals cause disturbances affecting those muscles on which we rely for our orientation in space.

V. Cyon formulates his theory of the labyrinth as follows:

1. The semicircular canals are the peripheral organs of space sense. Excitation of the nerve terminals in the ampullae causes sensations which allow us to form conceptions of

the three directions of space, one corresponding to each canal; to choose the direction in space in which our movements are to take place, and to co-ordinate the innervational cerebral centres necessary for the inception and retention of these motions.

2. The regulation and graduation of these innervation stimuli, in intensity and duration, as well as for those serving other purposive motions and for the preservation of equilibrium, are dependent mainly on the labyrinth, aided by visual, auditory, and tactile sensations and those derived from the oculo-motor apparatus, which after loss of labyrinthine functions may take its place more or less completely.

3. With the aid of these sensations of direction our brain forms the conception of an ideal tri-dimensional space upon which are projected and to which are referred all our other sensory perceptions which deal with the location of surrounding objects and of our own body in space.

4. The eighth nerve pair contains two entirely independent sensory nerves; the acoustic (n. cochlearis) and the spatial (n. spatialis, s. vestibularis.)

5. The disturbances manifested after loss of labyrinthine function are due to (a) visual vertigo caused by loss of correspondence between ideal space and that contained in the field of vision; (b) the resulting confusion of our conceptions of the position of our body in space and of its relation to visible objects; (c) to anomalies of degree and distribution of innervation to the muscles of the eye and body. Our ideas of time and number are derived from this complex of conceptions, and may be summed up in the following statements:

1. Orientation in time and the formation of time concepts is a function of the semicircular canals which give us an immediate conception of the direction in time in which external phenomena run their course.

2. Duration and rapidity, the most important elements in forming time concepts, arise in consciousness by the approximate valuation or exact measurements of time stretches, of which continuous time succession consists.

3. This continuity depends on the fact that there are no free intervals, i. e. no time gaps in the stimulation or sensations of our sensory sphere, and no threshold of stimulation.

4. The parts of the labyrinth which regulate the intensity spatially of innervation stimuli proceeding from the brain to the muscles, also control these motions in time, by means of the succession and duration of these innervations. They thus play a large part in the fine adjustment by which human speech becomes possible.

5. The knowledge of number which is essential for the timing of processes in the sensational and motor sphere is afforded by the arithmetically exact graduated (abgestimmten) sonorous vibrations of the nerve terminals in the cochlea and possibly in the sacculus.

6. In the cerebral centres to which these terminal excitations are transmitted and in which they are applied to measurements we have a true reckoning apparatus. The cochlea is to be considered as the arithmetic sense-organ on a basis of tone sensations, as the canal-apparatus is a geometrical organ on a basis of direction sensations.

7. The localization of the sense of time and space in the labyrinth gives a firm physiological foundation to the hypothesis of Weber and Vierordt of the general character of these mathematical concepts.

8. The formation of self consciousness and conceptions of the ego are due to labyrinthine functions. The O-point of the co-ordinates of space and of all directions in time corresponds to the consciousness of the individual.

Man and higher animals have three fundamental conceptions of direction, up and down, to and fro, forward and backward. Each specific direction corresponds to the stimulation of a definite canal.

Orientation in distance. Homing sense. This faculty cannot be explained as Ewald has attempted to do, by labyrinthine functions. Viguier assumed an influence of terrestrial magnetism, but as Darwin pointed out, this would merely

supply a magnet and the animals would also need a chart. (Not necessarily. The magnet indicates not only the position or direction of the magnetic North and South, but by unconscious comparison the direction in which the animal is moving. Memory of previous direction of flight aided by such a mechanism might well suffice to bring a carrier pigeon into eye shot of its own home.—P. H. F.) v. Cyon believes that pigeons "home" by means of a special speering sense (Spuer-sinn) which is probably located in the nose and frontal sinus and is not necessarily identical with smell. The force, direction, temperature, and possibly other qualities of the prevalent winds aid them to retrace their path, not always directly in reverse order, over points they have already passed. Where the winds are variable or very cold, the birds find their way with difficulty, as in the Alps or at sea.

Objections to the geotropic theory of Loeb. This author interpreted the data of the hydro-dynamic theory on the basis of terrestrial attraction of gravitation. All animals follow the pull of the earth in motion or position. Hence the dorsal aspect is always furthest from the centre of the earth. Disturbance of equilibrium is indicated by rolling about the longitudinal axis, turning turtle, and so on. v. Cyon claims that just the opposite is true. Only dead animals follow gravity, and then float on the back. During life they invariably oppose the action of external forces, including gravitation. Hence fishes face and swim up stream. This horizontal motion, even if it were with the current, could not be explained by geotropism. The loss of geotropic balance after section of the semicircular canals cannot be due to loss of static sense, as the oto-cysts and otoliths are not injured. The phenomena are defects, part of which are directly due to loss of control of muscles. The observations on dancing mice also contradict the geotropic hypothesis.

Adequate Stimuli of the Labyrinth. All sound vibrations whether perceived as tones, noise, or even beyond the limits

of acoustic perception, stimulate the vestibular apparatus, and cause motion of the otoliths. Directional impressions would not even require special terminal sense organs but could be explained by their central cerebral arrangement. Continuous stimulation of the inhibitory mechanism might be due to entotic and similar sounds, to rhythmic pulsations, to tension or to chemical irritation in the endo-and peri-lymph. These act mainly on the otocysts, while pure tone vibrations probably affect only the ampullae. The otoliths probably act as dampers. The graduation of the acoustic hairs indicates a faculty for regulated stimulation, and is quite compatible with their function as indicators or meters of innervation.

False conceptions of direction and inclination can be explained very simply by the influence of labyrinthine sensations. They occur even when visual judgment is excluded and do not depend directly on alterations in the position of the head affecting visual conceptions, but on changes in the position of the semi-circular canals. The delusions affect only the apparent sense (+ or —) of the directions, but dissimilar directions such as "down" and "left", are never confused.

The Physiological Basis of the Geometric System of Euclid. Those born blind have perfect conceptions of direction and space. Sanderson wrote a geometry, and Euler taught optics. Donders has shown that the blind have normal ocular motility. The eye can only form conceptions of space in front of us; the retina has no topographical peculiarity which would serve a tri-dimensional function; and the optic nerve carries only one form of sensation. The ear is anatomically as well as physiologically suited to perform the function in question. The three axes of dimension and space which physiological optics assume are actually present in the labyrinth.

1. A straight line is defined by Euclid as one which touches all parts located between its extremities. This merely means that it does not change its direction. Physiologi-

cally it is the path from a source of stimulation to the nerve point where a definite direction is sensed. The visual axis is the representation of this line.

2. A line can be extended in its direction, indefinitely. This corresponds to physiological sensations. Psychologically a straight line might be defined as the conceptual representation of a sensed direction. It follows physiologically, even more inevitably than geometrically, that a straight line is the shortest distance between two points. (Legendre.) Euclid's axiom that two straight lines cannot enclose a space, also means that they intersect in only one point. The various directions intersect psychologically in only one point, that of subjective consciousness.

All animals with labyrinths instinctively recognize the straight line as the shortest distance between two points, while others, as bees and ants move in arcs of a circle. The latter have no conception of a straight line.

Parallel lines are straight lines which never meet (or, which meet in infinity). Distance and direction are the geometrical, as they are the physiological, criteria of this quality. Parallelism is due to simultaneous stimulation of two parallel semicircular canals. Hunted animals instinctively recognize the fact that parallel lines cannot meet and seek to escape by keeping parallel to the pursuer, changing the direction of flight when necessary for this purpose. As v. Cyon says, they might fancy they could accomplish this end by moving in an opposite direction if they did not have the instinctively correct conception of parallels. Euclid defines an angle as the inclination of two lines which meet in the same plane without being in the same straight line. Physiologically this means merely the relation of direction of two lines which meet in or diverge from a point, namely our consciousness or in its externalization. The innate recognition of right angles depends on the arrangement of the canals in three right angles. Acute angles correspond to the intersection of the vertical superior canals in the middle of the sella turcica, and of the inferior posterior canals above

the posterior margin of the foramen magnum; obtuse angles to the intersection of the planes of the vertical and sagittal canal of either side.

A point is that which has no parts (Euclid), the intersection of two lines (Blanchet), or the limit of a line (Legendre). Physiologically, Euclid's definition is least precise and might be applied to consciousness, intelligence, or the soul. The point in question where all lines cross is subjective consciousness, the ego, itself, which has no parts and no extension. A surface corresponds to the identical sensations of direction in all the nerve terminals located in the plane of a single semicircular canal. The definitions of Euclid are not postulates or hypotheses, but the expressions of ideas which are formed directly by our sensory organs. Geometrical figures are incorporations of ideas of size in space, and not geometrical bodies. The axioms are direct conclusions from sense perceptions and are so closely connected with the latter that they seem to us the direct result of our observation (Anschauung). They need no mathematical proofs but only corroboration by actual experience.

Conclusions. Not our space concepts and geometrical ideas are pre-existent and inborn but the sense organs which produce them. Experience alone, as far as it depends on perceptions of the five sense organs (mainly the eye) cannot explain our ideas of tri-dimensional space.

Time Sense and Conceptions of Number. v. Cyon's experiments having shown that the labyrinth controlled not only the intensity but the duration and succession of stimuli, he proceeds to analyze this function and its cerebral mechanism. The sense of time, like that of space, had always been considered a general sense in distinction from special senses such as temperature, pressure, color, and so on. The distinguishing feature, according to E. H. Weber lies in the absence of multiples of sensation, of exact quantitative differences in the latter. Thus one light appears brighter, one color deeper, a certain pressure stronger than another but we do not

have an impression of direct valuation. Space and time conceptions, whether of visual or acoustic origin, on the contrary are characterized by measurement. A line appears not only longer, but in a given case twice or three times as long as another; a sound three times as long. These spatial and temporal values of the general senses present themselves spontaneously in consciousness (unmittelbar, i. e. without mediation of conceptions.) For an explanation of space, Weber had recourse to the hypothesis of sensation circles, according to which the special arrangement of nerve fibres in the peripheral tactile organs was a medium for space perceptions, analogous to the retinal space perceptions of Hering. This was attacked on anatomical grounds by Koelliker, Volkmann, and others. Weber concluded that the senses of smell and hearing are devoid of space conceptions and give no concepts of form because they lack these arrangements, i. e. sensation circles of the skin and retina. This hypothesis could naturally not be applied to the sense of time. Of all the elements of time, succession is the most directly perceptible, as an order or direction of internal and external phenomena. The more regular these phenomena are in point of time, the easier it is for our perceptions to follow and distinguish them in their time intervals. Hence the accuracy and directness of tone perception. The extension or direction of time corresponds psychologically to coming or being before and after, of phenomena or motions and is expressed by the sagittal direction, with the same co-ordinates as space sense. The O-point, again, is represented by individual consciousness. In time as in space, the ego is the centre of things. Past and future correspond to forward and backward. Simultaneity corresponds to parallelism and depends, like it, on simultaneous excitation of several canals. "Now" is not constantly changing as the metaphysicians assume, but ever still, the point in which past and future, themselves ever in flux, intersect. What was, and what is to be, go, one into the other, by changing merely from negative to positive values as they reach the present time of individual consciousness.

The second component of our sense of time is that of duration or rapidity, the latter being a function, algebraically, of duration. As rapidity is usually seen with the eyes, it was at first assumed that vision was the course of concepts of time flow and speed (Ludwig, Czermak). Accommodations and convergence were assumed to be the mechanism by which this time factor was measured. v. Cyon reminds us that convergence, as in fact all ocular motions, is not immediate but depends on stimuli originating in the labyrinth. Wundt objects to rapidity as a measure of time as it obliges us to measure space extension at the same time, as expressed in Vierordt's formula, which indicates that rapidity is not a pure time conception, but merely the relation of a space conception to time. Vierordt chose for actual time measurements the organ of hearing, and was able to analyze the significance of time differences, of rhythm, tact, and of time intervals. The time values determined by him were, however, not sensations of time but estimations of duration of acoustic impressions. There is no threshold stimulation or void in our actual time conceptions. According to Weber, the general senses enable us to measure special senses qualitatively in time and space, and Vierordt's tests merely determined the accuracy of this measure. In place of voids we have merely diminutions in the constant innervation of all our senses. It is unnecessary to assume special agencies, such as tonic muscular sensations (Muensterberg) to fill them out. Furthermore, such muscle sensations are not conscious and could not give us any time conceptions. Accordingly, our time conceptions are never interrupted. In sleep they appear to be greatly accelerated, probably on account of absence of the usual inhibitory action of special sensations, particularly those of the labyrinth.

The advantages of the ear for conceptions of time consist in its possessing an apparatus for our knowledge of number, and that its conceptions have no spatial admixture. The elements of rhythm and tact in periodic and successive tone sensations are also of advantage, as are the great range

of stimulation, (10 octaves as compared to the sixth of color perception), and the accuracy and delicacy of tonal sensations analysis of chords, absence of after images (P. H. F.), and finally the absence of all complicating admixtures of space conceptions.

Rhythm and Tact in Motion and Sensation. Periodicity in the ebb and flow of the tides, sunrise and sunset, in the regular succession and return of day and night, and of the seasons, were the first phenomena to call man's attention to time. Even subjective sensations of marked periodicity, such as hunger and thirst, pulse and respiration must have suggested a similar idea. This periodic return in rhythmic intervals is associated with the conscious idea of regularity. As the hand (span) or foot was used for the shortest measure of space, as the most accessible one supplied by the human body or its surrounding, so the change from day to night was taken as a time measure. The smallest interval of time which we call a second is probably based, according to Karl v. Baer, on the pulse rate, which in advanced age is generally 60 to the minute. While time-concepts regulate our innervation in sequence and duration, rhythmic motion appears only under the influence of rhythmic tone sensations as in marching, dancing, or exercising to music. The acme of rhythmic sensation and motion is reached in the development of speech and of eye motion with their unerring accuracy. Hence deaf mutes who cannot hear the result of their vocal efforts have to be taught to use visual impressions as a practical substitute, just as doves deprived of their labyrinths have to learn to walk again. Deaf mutes have an imperfect consciousness of time, and as this is necessary for the psychical orientation in all mental processes as well as for body motions, the intellectual inferiority of these defectives is almost a matter of course.

The perception of tones is not indispensible for the motor regulation by the labyrinth, as many motions requiring accurate co-ordination in duration and succession are not connected with audition, but depend mainly on the innate

numerical sense which is put in action by reflex from the labyrinth. Rhythm and tact of non-tonal vibrations (sound) have a marked effect in facilitating the innervational distribution, as in the concerted cries and calls of sailors and workmen in lifting heavy weights. Harmonic tone sensations seem to have an influence on pulse rate quite independent of any aesthetic or emotional content, evidently due to alternated rhythm and tact of the sounds alone.

While conceptions of space are not dependent on number concepts, the sense of time absolutely demands them. The cochlea, with its graduated structural elements and accurate reckoning of minimal vibrational differences, is the natural counting mechanism of the mind. The extraordinary development of the mathematical sciences gave rise to the assumption that they were purely intellectual products and devoid of any physical basis in sensation, but v. Cyon concludes that our elementary concepts of number and space inevitably lead to the necessary formulation and development of geometric and arithmetic rules and principles. Harmonic tone sensations were not originally given to man to enable him to enjoy the symphonies of Beethoven or the fugues of Bach, or to develop Maxwell's equations. These faculties, like the corresponding faculties of space sense, are the result of psychological evolution. v. Cyon calls attention to the history of philosophy and notes that in classical antiquity music was a part of mathematics, logic, and state craft, not, as in modern times for its aesthetic and emotional influence, but as the most evident representation of law and order. Space and time seem finite when referred to the tactile and visual field. Infinity is possible only in dependence on direction, as to space, and on number, as to time, for number like direction is capable of unlimited development.

Mathematical and musical gifts are often noted in precocious youth. According to v. Cyon they depend on the same organ. He explains the preference of some mathematicians for number and arithmetic operations, and that of others for geometrical and graphic representation as de-

pendent on the individual degree of development and delicacy of function of the cochlea in the one case and of the vestibular apparatus, in the other.

This brief and general survey of some theories of labyrinthine function has led us into the rather thin air of metaphysical and philosophic introspection. From these heights the solid ground of clinical activity seeems distant and vague, and our own position far removed from every day life. Our excursion into the realms of space and time is, as it were, symbolic of the specialty we follow and which leads us, if we think, out into the broader fields of medicine and finally to the vast and unbounded regions of human mind and universal ideas.

Discussion.

Dr. George E. Shambaugh, Chicago:—The older physiologists looked upon the labyrinth of the ear as a mechanism which had to do solely with sound perception. They distributed sound perception over the three types of end organs in the labyrinth as follows: tone perception to the organ of Corti in the cochlea, noise perception to the macula acoustica of the utricle and sacule, and to the crista acoustica of the semicircular canals was attributed the function of determining the direction from which sound comes. This work of von Cyon is very interesting but that his conclusions regarding the function of the end organs in the vestibule and semicircular canals will ever replace the theory of Mach-Bruer seems extremely doubtful. The latter conception of the function of these end organs is substantiated so thoroughly by pathological data as well as by physiological experiments, especially those of Von Stein and Barany. If our geometric sense is dependent on the semicircular canals it should be possible to demonstrate an absence of this sense in deaf mutes where this apparatus has been destroyed.

Dr. B. A. Randall, Philadelphia:—Streeter's works with tadpoles where he has transplanted the semicircular canals,

and upset the equilibrium of the tadpole so that he cannot guide himself at all and is turned topsy turvy, is a confirmation of the Mach-Breuer theory.

Dr. Percy Fridenberg, New York, (closing remarks):—I agree with Dr. Shambaugh absolutely that this psychological system cannot take the place of definite impulses, but I think v. Cyon's idea of our general sense of time and place being dependent upon the function of the ear has a great deal to recommend it. It is remarkable that v. Cyon seems able to prove almost anything from his point, and all the experiments on deaf mutes, he says, go to prove that he is correct. He says if the semicircular canals are the cause of sense of rotation then the deaf mutes who haven't got them should not have any disturbance of balance whatever, and should be born tight rope walkers, but the experiments of James have shown that when deaf mutes have been deprived of sight they lose the sense of direction. If the Mach-Breuer theory is correct they would have loss of balance, which has not been noted.

SUBJECTIVE AND OBJECTIVE SENSE OF SOUND PERCEPTION.

By D. BRADEN KYLE, M. D., Philadelphia.

Physiologically, anatomically, and mechanically, we have normal hearing as well as normal seeing. We have our tests for the normal, and any deviation from this, we call abnormal. An individual may fail to meet the normal tests; yet it is a **physiological** failure. For that individual, it is his normal sight or his normal hearing. Another individual may fail to meet these tests, owing to some structural alteration in his physiological hearing or sight. His, then, is a **pathological** condition. The subjective sense of sound perception and the objective sense of sound perception, in each individual, can be determined, then, to a large extent, by tests; yet it is not always an easy matter to determine by these tests whether this diminution or exaggeration, whichever it may be, in these senses of sound perception, is a physiological one or a pathological one. We certainly do not all hear alike, any more than we see alike. The peculiarity of the objective sense of sound perception to various sounds and tones is frequently illustrated. The same is equally true of the subjective sense of sound perception,—the individual's ear, through his subjective sense, giving him a false note; not to **his** subjective sense of sound perception, but, unfortunately his differs from the majority. There is produced in hearing, as we would call it in anatomy, an anomaly, yet to the individiual it is physiological. This is illustrated in the singing and speaking voice. The individual with the excessively loud voice, in the majority of cases does not know **individually** that he speaks in a loud tone, but his family and friends are constantly reminding him, and by a system of training he can modulate his tone from a disagree-

able, high, rasping voice, to a more pleasing one, yet his subjective sense of sound perception, which is a diminished one, does not tell him that he is speaking in a loud tone of voice. On the other hand, the individual with a sensitive or exaggerated subjective sense of sound perception speaks in an unusually low tone, for individually, his voice sounds to him much louder than it really is. I have observed several such cases.

The same peculiarity will exist in individuals who sing. In some, this peculiarity is limited to one or two tones, their subjective sense of sound perception is wrong in one or more tones, and they have to train their subjective sense to a false tone, in order to have it correct and correspond with the objective sense of sound perception, and to agree with what is known as normal.

Another class is the individual whose subjective sense is entirely wrong, especially as to the musical ear,—the individual who thinks he can sing, and whose own sense of sound perception tells him that his voice is right, but unfortunately it does not agree with the normal standard of tone, and his voice will not harmonize with others or with the instruments. We frequently see such examples in individuals who have gone from one instructor in music to another, vainly striving to cultivate their voice, and not being able to understand why they could not succeed, because to their own individual sense of sound perception their voice is correct.

In observing a number of these cases it has occurred to me that probably these peculiarities as to subjective and objective sense of sound perception might have considerable bearing on our hearing tests, and naturally would have a great bearing on the diagnosis and especially on the prognosis in deaf cases. I have noticed that some individuals with practically little structural interference with the drum and hearing apparatus are deaf out of proportion to the parent nerve and structure involvement. Is it not possible that these cases originally were physiologically defective? From a subjective and objective sense of sound perception,

then, with a slight pathological alteration, this change, not only from a physiological but a pathological standpoint, will be more marked and the effect greater on the individual subjective and objective sense of sound perception.

Another peculiarity which I think probably is influenced by these senses of sound perception, is that in certain individuals who are slightly deaf, or others more markedly deaf, their deafness consists in simply a limitation of the field of hearing, corresponding very much with the limitations in the field of vision. But when they do hear, or when the sound is within their range or field of hearing, they hear it distinctly and clearly, while in other individuals, when the sound reaches the border of their field of hearing, and even up to almost direct contact with the ear, the sound is muffled, and they do not hear it distinctly. These cases show in the individual a peculiarity; in the latter variety, the one in which the sound is always muffled, the patient invariably has the anxious, strained expression of trying to hear, while the former variety, in which there is simply a limitation in the field of hearing, do not have this strained facial expression; they either hear distinctly or they do not hear at all, and are not catching partial sounds. Personally, I think that these variations must depend on the two conditions, and if such a condition exists in the individual, then we will get a peculiarity as to hearing, and in such cases our tests of hearing will not be normal, and both our physiological and pathological tests would not agree with what we call the normal standard of tests for hearing. So that from my observation I would think that we have, first of all, a normal subjective and objective sense of sound perception, the two senses being in unison and degree, like a pair of perfect eyes. Then we have, secondly, a physiological subjective sense of sound perception and objective sense of sound perception which are not in unison. This is physiological, anatomical and structural, and not due to any diseased process. Then, from pathological conditions we have alteration not only in the normal cases, but also in the abnormal

physiological cases. It seems to me certainly, then, that all tests in these conditions would not be accurate.

From a treatment standpoint, certainly, the individual with a physiologically perverted subjective and objective sense of sound perception, followed by some pathological alteration in the hearing apparatus, would not respond to treatment as actively and as definitely as an individual not having these peculiarities, and that from a diagnosis, prognosis and treatment standpoint, this observation is worthy of consideration.

In the individual with the defective physiological subjective sense of sound perception or objective, one or both, not being physiologically up to the standard, when any lesion of the hearing apparatus occurs the alteration as to hearing and structure would be out of proportion to one having originally normal subjective and objective sense of sound perception.

Discussion.

Dr. Geo. E. Shambaugh, Chicago:—Whether a sound is produced outside the body or within the head, it must travel the same route in order to lead to sound perception. All sound waves to be perceived must pass through the labyrinth. The phenomena referred to by Dr. Kyle where one person unconsciously pitches his voice too loud and another too low is to be explained usually on the basis of increased or decreased bone conduction. In those cases where the defect in hearing is due to an obstruction in the conducting mechanism, bone conduction will be invariably increased above the normal and these are the cases where the voice is pitched too low, for the reason that the increased bone conduction makes the sound of their own voices out of proportion, too loud. On the other hand when a person with defective hearing pitches the voice too high this alone is a pretty positive evidence that the deafness is due to internal ear trouble with greatly diminished bone conduction.

Another phenomenon referred to is that where there is perception for a false tone. Some persons fail to recognize fine differences of pitch. This is probably psychological. On the other hand where a person hears a tone too high or too low this is a pretty sure indication of a disturbance in the labyrinth. Even when this phenomenon is associated with an evident middle ear lesion it seems probable that the diplocousis is the result of disturbance in the labyrinth. The only plausible explanation that has been suggested is some interference with that structure in the labyrinth which responds in sympathetic vibration in its several parts to tones of different pitch. For example when the part of this mechanism which normally responds to c4 is weighed down with a blood clot or some exudate it will cease to vibrate for c4 but will respond to a tone of a different pitch, thus giving the perception of a false tone.

Dr. Edw. B. Dench, New York:—I would simply like to ask if I understood Dr. Shambaugh that this failure to appreciate proper pitch is always dependent upon an internal ear lesion? I know of certain cases of midde ear lesion where this has been present and cleared up on cure of the middle ear trouble. I do not think it can always be due to a lesion of the internal ear.

Dr. B. A. Randall, Philadelphia:—Dr. Kyle is certainly right that our tests deserve a great deal more consideration and working out than they have yet had: in many respects they are false. This subject was also confused a good deal in ophthalmology and even Von Graefe wrote about the "myopia for distance," not recognizing, great student as he was, that the myope of 1 D or so could not see outside of his own arm's length: he was not myopic for distance.

As to special tones for which one ear is defective, there is much we have yet to learn and studies in the line Dr. Kyle has taken up have great possibilities of advantage to us and will enable us to eliminate some of these false tests.

Dr. Norval H. Pierce, Chicago:—I am reminded of a man in Chicago, son of a very wealthy father, who is slightly defective mentally, but perfectly normal physically. He has apparently an intense love of music and made application for entrance into a well known choir. He was invited to have his voice tried; the choir master ran the scale on the piano and said, "Please follow me while I run this scale of C." Each note the master struck was in the mind of the applicant but one single sound, ah, ah, ah, and in his own mind he thought he was singing that scale.

Regarding the change in pitch which occurs in disease of the ear I think that the fact that in musicians when this occurs, at certain times of the day they will hear normally precludes the idea that the lesion can be in the internal ear.

Dr. D. B. Kyle, Philadelphia, (closing remarks):—I did not mean in the illustration of the loud and the low voice that there was anything wrong with the hearing. This was a peculiarity in which there was no defect of hearing.

TONE-PERCEPTION.

By W. SOHIER BRYANT, A. M., M. D., New York, N. Y.

In the fourth century, B. C., Empēdocles referred the auditory impressions to the cochlea. From his time until the nineteenth century, there was no marked advance in the theory of sound-perception, the general explanation of the phenomenon being on a tactile or pressure basis.

Helmholtz found a very fertile suggestion for a basis of the theory of sound perception by sympathetic vibrations in the description of the cochlea as a sound-perceiving mechanism with a basilar membrane containing fibres, whose length varied successively, from the longest at the apex of the cochlea to the shortest at its base.

This explanation of the arrangement of the basilar fibres which was made by Hensen, Helmholtz made the foundation of his final theory, which is called the "piano-string theory" of sound-perception. His theory is, briefly stated, that each basilar fibre responds sympathetically to a definite tone, and stimulates the hair cell of the neuro-epithelium of Corti's organ which rests upon the fibre; and that the nerve impulse from this stimulation of the hair cell is carried to the brain as a stimulation of a definite cell corresponding to a definite note. The higher tones, according to Helmholtz, are perceived at the base of the cochlea and the lower tones at its apex.

The objections to this resonance theory of Helmholtz are:

The phylogenetic development of the mammalian ear from the lowest vertebrate ear shows nothing of a sound-selecting device corresponding, in any way, to Helmholtz' supposition with regard to the human cochlea.

The next objection is an anatomical one, namely, that

there are not enough fibres and they are not of the various relative sizes required to respond to all audible notes[1]. The structure of the basilar membrane is a basement aponeurotic membrane with fibres running transversely and longitudinally, and covered with relatively thick masses of cellular tissues and blood vessels. Fibres in such a mass could not vibrate individually, and therefore, could not vibrate sympathetically to any tone. Furthermore, if tone perception depended upon sympathetic vibrations, variations and inaccuracy in tone perception must always be found because of the delicate and unstable tension of living fibrous tissues serving the purpose of resonators.

The so-called **sensitive hair theory** seems to the author to be the most plausible and most satisfactory explanation of the phenomenon of sound-perception. Briefly stated, the theory is: A sound wave after it has been transmitted through the external and middle ear, and has entered the labyrinthine fluid, beats upon the sensitive hair band, formerly called the tectorial membrane. **These long sensitive hairs appear, to the author, to be the means of the transmission of the sound wave impulses to the neuro-epithelial cells.** The sound waves pass over these sensitive hairs in much the same way as wind passes over a corn field. The motion of the hairs thus caused is transmitted down the hair to the neuro-epithelial hair cell which transforms it into a nerve motion, and the perception takes place in the higher centers of the brain, the sound waves not being analyzed in the cochlea as is generally supposed. Differences in the rate of propagation, in the wave length and in the form of the wave, produce different movements of the sensitive hairs, which are interpreted as different sound sensations by the sensorium.

This sensitive hair theory is based on the phylogenetic and ontogenetic development, and upon the latest histologic findings of the structure of the organ of Corti.

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(1) Bryant, W. Sohier. The Piano-String Theary of the Basilar Membrane. Archiv. of Otology. Vol. XXXVII., No. 2, April, 1908, pp. 127-130.

Let us first consider the phylogenetic development of the Organ of Corti.

The organ of sound-perception or the Organ of Corti is merely a specialized portion of the general tactile sense organ of the lowest vertebrates, without any specialized power of sound selection.

In the tunicates, and even in the lowest of the vertebrate series, the undifferentiated tactile sense alone perceives molar and molecular motion of the surrounding aqueous medium. The first advance towards a differentiation of function appears in the fishes where the lateral line canal organs first appear. These organs are formed by invagination of the cuticular layer and are provided with clumps of specialized sensory epithelium. Because of this specialized epithelium and because of the canal form, these organs have a more highly developed power of noting the molar and molecular movements of the surrounding water than the undifferentiated surface of the body of the lower forms.

There is very strong evidence to justify the statement that, as specialization advances in the ascending series, a part of this canal system is set apart and endowed with still more delicate and specialized power of molecular movement-perception, a definite tone-perception. This change is brought about first by the separation and enclosure within the head of a specialized portion of the canal organ which has now become a labyrinth.

The legena—an offshoot of the primitive labyrinth—first appears in the fishes. The legena becomes further specialized in the higher reptiles and birds by the greater development of its papilla basilaris. Still further specialization takes place in the mammals by the development of the legena into the cochlea with its organ of Corti.

To go back to the primitive condition of the lateral line canal organ, we observe that certain of the epithelial cells are specialized and furnished with filaments or hairs which facilitate the perception of the molar and molecular motion

of that part of the circumambient fluid which circulates in the canals. This hair-bearing epithelium persists throughout the vertebrate series, changing only in grouping and in its increasing specialization, and continues to be bathed by the fluid originally communicating with the surrounding water, but which in the higher forms is enclosed within the labyrinthine capsule. The function of the epithelium also continues to be the same, except for the specialization

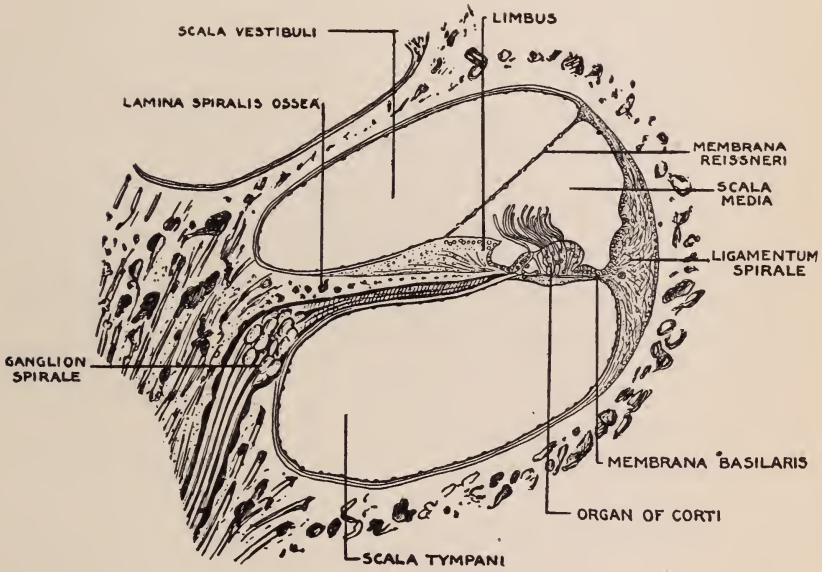

FIG. I.

From Knight and Bryant's, "Nose, Throat and Ear." Shows a diagram of a turn of the human cochlea. The organ of Corti is seen with its long tectorial hairs.

of certain groups of the hair-bearing epithelial cells adapted to the perception of special forms of molar and molecular motion. The epithelium that concerns us in sound perception, while it is specialized for the perception of molecular wave-motion or sound vibrations, has not lost its primitive type.

We will not consider in detail the ontogenetic development of the organ of Corti because it proceeds along parallel lines to the phylogenetic development.

Histologic structure of the organ of Corti. There are several highly specialized portions of the labyrinth of the higher vertebrates which long baffled investigators, and were long subject to misinterpretation. The Organ of Corti alone concerns us as specialized for sound perception, but by

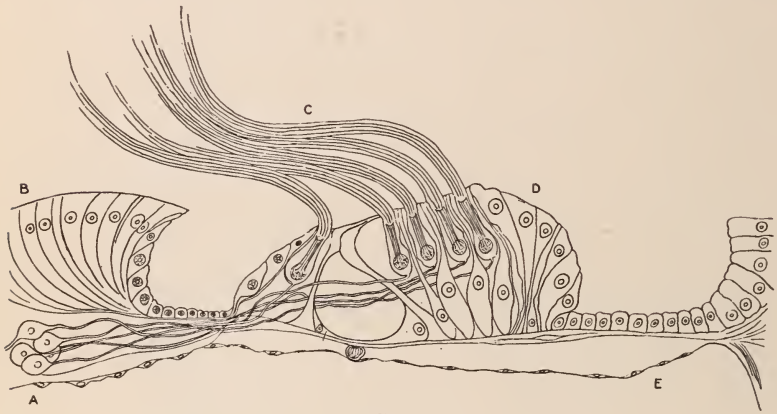

FIG. II.

From Knight and Bryant's, "Nose, Throat and Ear." Shows a diagram of an enlarged human organ of Corti with long tectorial hairs.

(a) Spiral ganglia.
(b) Limbus.
(c) Tectorial hairs.
(d) Supporting cells and organ of Corti.
(e) Basilar membrane.

the consideration of the other portions, we can make our point clearer.

In mammals, the epithelium of the cristae and the maculæ acousticæ are provided with long hairs. For a long time the relation of the hair and hair cells of the cristæ and the maculae acousticæ in the lower vertebrates was misunderstood, owing to the condition in which the histologists found the hairs. They appeared transformed into a mass which at

first was called a tectorial membrane, or "cupola," from its shape. Finally, it was proved that the tectorial membrane or cupola was really made up of the bulk of the hairs of the neuro-epithelium and that the reagents employed in the manipulation had made this artifect of them. More recently it has been proved that the tectorial membrane of the papilla basilaris legenæ in reptiles and birds, and later still the tectorial membrane of the organ of Corti in mammals, are artifects similar to the cupolas and really are an amalgamated mass of hairs of the neuro-epithelium. The author has verified this fact on fresh adult human cochleae. These structures have been shown to be extremely susceptible to alteration from chemical reagents. The certainty of destruction of the hair band, even with the mildest reagents, proves its delicate structure, while its physicial form, long elastic filaments, indicates a sensitiveness to molecular movement unsurpassed by any other structure of the body. The distorted appearance of the hairs making up the tectorial membrane and the consequent errors in the observations were due to the fixing and staining reagents to which they were submitted. The hairs and the hair cells of the organ of Corti exhibit no special change from the hair cells of the legenæ.

The histological proofs of these facts have been worked out by following the developmental series, beginning at the lowest mammals and noting the persistence of the hairs when no reagents were used, and their disappearance after the use of reagents.

Professor Howard Ayer deserves the credit for establishing these facts[1].

Will this theory of undifferentiated sound-perception by means of the sensitive hairs fulfill the acoustic require-

(1) Ayres, Howard. Vertebrate Cephalogenesis, Pt. II. A Contribution to the Morphology of the Vertebrate Ear, with a Reconsideration of Its Function. Amer. Journ. of Morphol. Vol. VI, 1892, pp. 1-360.

Ayres, Howard. On the Membrana Tectoria, the Membrana Basilaris, and the Nerve Endings in the Human Ear. Zoo. Bull. Boston, Vol. I, 1898, pp. 275-278.

ments? We find that it will, and better than any other theory, and for the following reasons: Every property of a sound wave is shown in the characteristics of the wave front; these characteristics are variations in the curve of the wave and we find that they are transmitted in every particular to the hair band.

Every property of the sound wave is represented in the form of the wave. Every character of the wave form is imprinted upon the sensitive hairs of the neuro-epithelium of the organ of Corti. The neuro-epithelium transform the molecular sound vibrations into nerve impulses. The per-

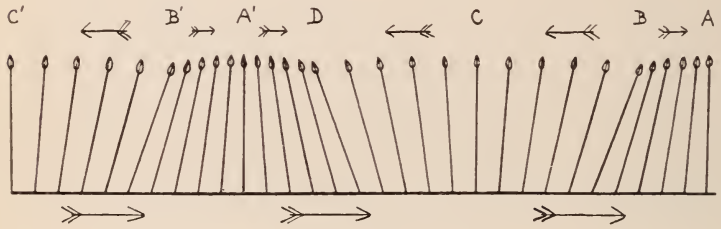

FIG. III.

A diagrammatic representation of the waves produced by wind passing (in the direction indicated by arrows below the figure) over a corn-field. The upper arrows indicate the direction of motion of the stalks of corn.

The wave has not yet reached A; at B the displacement in the direction of the wind is now maximum; between A and B the maximum displacement has not yet been reached; between B and C, the maximum having already been reached, the stalks are now returning to their vertical position; between C and D the stalks having returned to their vertical positions, are now moving in a direction opposite to that of the wind. At D the displacement in the opposite direction to the wind is now at the maximum. Between D and A' the maximum oscillation in the opposite direction to the wind having been reached the stalks are now returning to their normal positions, so that the stalk A' has successively gone through the various stages from A to A', and it will the next instant begin moving with the wind again. The oscillation between A' and C' are like those between A and C, except that they are being repeated for the second time.

ception of tone depends upon the power of the brain to interpret the stimulus transmitted by the cochlear nerve.

The sound waves which enter the labyrinth from the

middle ear in man, enter the perilymph, pass through the membranous walls to the scala media, and beat upon the long delicate hairs of the organ of Corti, without any mechanism for the differentiation of special tones, just as they did on the maculæ acousticæ of the fish or the sensory tufts of the lateral line organ.

The impulses received from the hairs of the organ of Corti are transmitted to the cochlear nerve endings and the cochlear nerve carries the stimulation to the auditory center in the temporal lobe of the brain. The accuracy of the analysis of the sound is proportionate to the education of the individual in the matter of tone perception.

This theory has, on the face of it, the advantage of simplicity over the resonance theory. Before the sensitive hair theory can be at all worthy of consideration, it must explain the various phenomena of sound perception at least as well as, if not better than, the Helmholtz theory[1].

The phenomena which a theory of sound perception must explain and which it is proposed to consider here are chiefly the perception of:

(1) Pitch, intensity, and quality of tone;
(2) Consonance and dissonance;
(3) Music and noise;
(4) Combination tones;

besides several minor points.

It is well known that the pitch and intensity of a sound are dependent respectively, upon the vibrational period and amplitude of the sound wave. Now, it is easy to see how the differences in the rate of propagation and the amplitude of the wave, as it passes over the so-called tectorial membrane or hair-band, give rise to differences in the manner of stimulation of the nerve endings. The difference of stimulation for various vibrational periods is a difference of rate of recurrence of the stimulation of the nerve endings. The

(1) Bryant, W. Sohier. Die Lehre von dem schallempfindlichen Haarzellen. Archiv. f. Ohrenhlk. Bd. 79, 1909.

difference of stimulation for various amplitudes is a difference in the intensity of the stimulation of the nerve terminals. So that for a given vibrational period and amplitude, there is one definite kind of stimulation of the auditory nerve which, resulting in a perfectly definite sensation, is consequently characteristic of that particular sound.

The first serious difficulty we encounter is in the explanation of the perception of quality of tone. It was formerly believed that the quality of a tone depended upon the **form** of the wave—this being the property of a wave which had not yet been correlated with any tone-property. The work of Helmholtz[1] has conclusively shown that differences in quality are due to differences in the number, order and

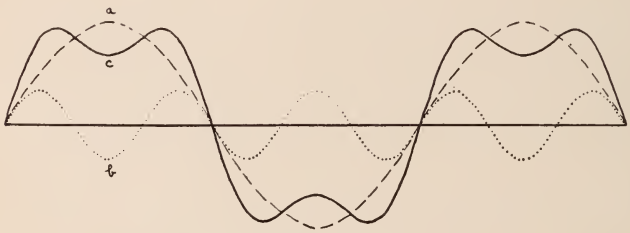

FIG. IV.

Diagrammatic curve of sound waves of Fundamental (a) and Second Overtone (b) in the same phase, showing the resultant curve, (c). All the plotted diagrams of sound wave curves represent the to and fro motion of the sound wave transformed into an up and down motion.

relative intensity of the upper partials present. In so far as these properties of a tone influence the form of the resulting wave, the old theory of tone quality is acceptable. Helmholtz[2] further says, however, that a difference in **phase** of any one of the partials must cause a change in the form of the wave (See figs. 4 and 5), but **does not** produce a corresponding change in the quality of the tone. His conclusion is that, although every variation in quality will

(1) Helmholtz. Die Lehre von dem Tonempfindung. Braunschweig, 1896, F. Vieweg & Son.

(2) Loc. Cit. Chap. VI.

be represented by a variation in the wave-form, a variation in the wave-form does not necessarily correspond to a variation in tone quality, and Helmholtz, therefore, goes on to explain this matter on the basis of the resonance theory. He says: "The ear, therefore, does not distinguish between the different forms of waves individually, as the eye can distinguish pictures of the various vibratory forms; the ear, rather, separates the wave-forms into simpler component parts according to a definite law; it has the sensation of these simple components separately as harmonic tones; it can, after considerable trained attention, became conscious of them individually, and it distinguishes as separate tone colors only various combinations formed from these simple sensations"[1].

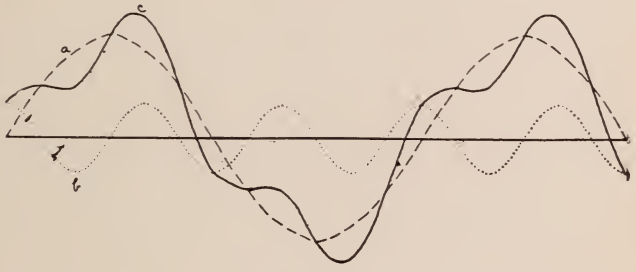

FIG. V.

Diagrammatic curve of Sound Waves of Fundamental (a) and Second Overtone (b) in different phases showing the resultant curve (c).

This conclusion is unnecessary if we consider the objection which may be raised to the experimental work of Helmholtz in this connection. In the experiments he performed to determine the relation between phase and quality, the tones were not sounded simultaneously, but in succession and consequently, a slight change in quality might have escaped his notice. Indeed, he says, "No change of the sound color can be perceived, at least not clearly enough to be recognized at the end of the few seconds required to alter

(1) Loc. Cit. p. 209.

the apparatus."[1] We find then, a difference in quality produced by difference in phase of the upper partials which makes this phenomenon coincide with the old Helmholtzian theory of tone quality.

As for unmusical sounds which correspond to high upper partials, Helmholtz says: "We cannot extend our experiments to the latter, and must, therefore, leave the question in doubt for the present whether, in the class of dissonant tone phase, differences occur. Later theoretical considerations will make it probable that this is the case."[2] Further, the more recent work of Koenig[3] whose experiments with the wave siren certainly admit of very much more precision[4] has led him to conclude "that quality depends upon the number and relative intensity of the upper partials into which the tone can be analyzed, and that the importance of the difference of phase of these harmonics cannot be overlooked. If a change in the number and relative intensity of the harmonics cause a difference in timbre, such as is noted in instruments in different classes, or such as the human voice gives to the different vowels, the changes of phase among the identical overtones are capable of producing just as marked differences in timbre as those noted among instruments of the same class or between the same vowels sung by different voices[5].

The conclusiveness of Koenig's work in this connection has been questioned by Hermann[6]. The latter performed his experiments with tuning forks and not with the improved wave siren used by Koenig. Hermann found that there was a change in intensity corresponding to a change of phase, such that the resulting wave was one of greater

(1) Loc. Cit. p. 207.

(2) Loc. Cit. p. 207.

(3) Keonig, Quelques Experiences d'Acoustique, Paris, 1882, also Wiedermann's Annalen, 57. 1896. pp. 555-556.

(4) Ellis, Sensations of Tone, Translated from Helmholtz, "Die Lehre von dem Tonemfindung." 1895, p. 537.
London, Longmans, Green and Co.
Quelques Experiences d'Acoustique, p. 242.

(5) Loc. Cit. p. 242.

(6) Wiedermann's Annalen, No. 58, pp. 391-401.

amplitude. But, he adds. such a change in **intensity** should not be regarded as a difference in **quality.** According to the Helmholtz theory, however, a mere change in phase ought not to produce any change in the impression whatever. Hermann recognizes this fact and defends his attitude by saying: "As the ear, however, probably possesses other portions appertaining to resonance perception besides those that perceive sound, may not the intensity of the result also

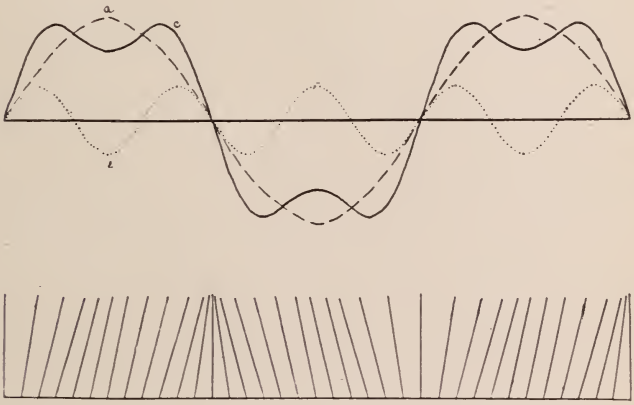

FIG. VI.

Diagrammatic curve of sound waves showing the effect produced by the resultant wave (c) upon the hairs of the hair-band (d). The diagram represents the to and fro motion of the sound waves transformed into a combination of the to and fro motion with the up and down motion. This up and down motion is necessitated by the fixed attachment of one end of the hairs.

play a part."[1] In other words, his own experimental work does not bear out the Helmholtz theory, and consequently, Hermann indefinitely attributes the perception of this difference in phase (which he does not deny) to another part of the ear, thus adding a further complication to the already complicated theory. At any rate, all agree that a change in phase is perceptible. We have disposed then of the

(1) Wiedermann's Annalen, No. 58, p. 398.
(a) Fundamental tone; (b) Second Overtone; (c) Resultant curve of (a) and (b); (d) Hair-band.

last objection to the statement that the form of the resultant wave produces an alteration in tone perception.

In view of these facts, there is no reason why we should not accept the old theory that the quality of tone is dependent upon the wave form. And, granting this, the sensitive hair theory easily accounts for the perception, not only of pitch and intensity, but also of quality; for a wave of a given form corresponds at any instant to a definite intensity of stimulation of the cochlear nerve endings, through the medium of the hairs of the hair-band. (See Fig. 6.)

In his book on "Sensations of Tone," Helmholtz investigates the nature of dissonance. He finally defines it as follows: "If two musical tones are sounded together, or beside each other, there is usually a disturbance of their consonance owing to the mutual vibrations caused by their partial tones. As a result, greater or lesser portion of the volume of sound resolves itself into separate, detached tones, and the combined resonance becomes harsh. We call this dissonance[1]. In cases where no beats are formed there is no such roughness; we call this exceptional consonance[1].

It is easy to see, therefore, that for the explanation of the perception of consonance and dissonance, the resonance theory is quite unnecessary, since the presence of beats alters the form of the sound-wave, and any alteration in the wave is communicated to the auditory nerve.

For the distinction between musical tones and noises, it is well known that the former are due to periodic waves, and the latter to irregular, non-periodic impulses. This again is a question of wave-form, and hence the elaborate resonance theory is here too superfluous[2].

As regards combination tones which Helmholtz classifies as **differential and summation** tones, according as their pitch

(1) Helmholtz. Loc. Cit. p. 320.

(2) Hensen, V. Die Empfingungsarten des Schalls. Arch. f. d. Ges. Physiol. Bonn. 1907. CXIX. S. 249-294.

Myer, Zeitschr. f. Psychol. u. d. Sinnesorg. XVI, 1897.

Stumpf, C. Zeitscher. f. Psychol. u. Physiol. d. Sinnessorg. 39, 1905, pp. 205-268.

numbers are equal to the difference or the sum, relatively, of the pitch numbers of the two tones sounded simultaneously,—these combination tones are not subjective, as had been supposed, but their objective existence had been conclusively demonstrated[1]. Now, just as soon as any sound phenomenon is shown to have an objective existence in the transmitting medium, it must be related to some property of the sound wave, and any property of the sound wave is directly impressed upon the auditory nerve endings. (For a complete statement of the previous experiments and theories of combination, differential and summation tones, the reader is referred to the exhaustive monograph by Joseph Peterson[2].)

There is still another argument which Helmholtz brings forward in favor of his theory. This is in connection with the fact that shakes in the upper part of the scale are more clearly perceived than those in the lower part[3].

To quote Helmholtz again: "If, for instance, an elastic body is set in sympathetic vibration by a tone, it vibrates at the same rate as the exciting tone; as soon as the latter ceases, it vibrates at the rate of its own tone. If the ear now vibrates as a whole system and is capable of distinct after-vibrations, it must vibrate at its own rate, which is quite

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(1) Belas, P. E. On the Structure of Waterjets, and the Effect of Sound Thereon. With a note on Combination-Tones by W. F. Barrett. Royal Dub. Soc. Proc. 10. 32. pp. 360-372, 1905.

Stumpf, C. Differenztöne und Kosonanz. Zeitschr. f. Psychol. u. Physiol. d. Sinnesorg. 1905. bd. 39, pp. 269-283.

Waetzmann, E.

(a) Objective Kombinationstöne an der sigenden Rogenlamps.—Phys. Zeitschr. 8 pp. 346-347, 1907.

(b) Zur Frage nach der Objektivatät der Kombinationstöne. Ann. d. Phys. 20. pp. 837-845, 1906.

(c) Ueber die Kombinationstöne. Beitrage zu. Anat. Physiol, etc. des Ohres, etc., Vol. I, 1908. p. 216.

Peterson, Joseph. Combination Tones and other Related Auditory Phenomena. Balto. 1908. Psychol. Monog. Suppl. vol. IX, No. 3. Whole No. 39, p. 1-136.

Schaefer, K. N. Ueber die Erzeugung physikalischen Kombinationstone mittels des Stentortelephone, Ann. d. Phys. 17.3 pp. 573-583, 1905.

Hermann, L. Zur Theorie der Kombinationstöne, Ann. d. Phys. 25, 4. pp. 697-714. 1908.

(2) Peterson, Joseph. "Combination Tones and Other Related Auditory Phenomena." Physchol. Review, Balto. Psych. Monograph Supplement. Vol. 1X, No. 3, Whole No. 39, 1908, p. 1-136.

(3) Helmholtz, Loc. Cit. p. 235.

independent of the rate of the previous tone that excited this vibration. It would follow, therefore, that a trill is equally difficult on a high or low tone."[1]

The deductions of Helmholtz in this connection are certainly not clear. When a shake is being executed the musical sound is continuous, although the pitch alternates rapidly back and forth, and therefore, there is here no question of the proper tone of the ear, which Helmholtz mentions, which would come into play only after the exciting tones had ceased and not during the shake. Furthermore, since it required a greater force to produce a low tone than it does a high one, it is more difficult to stop the momentum which produced the lower tone. It is only natural then that the tones of a shake in the lower part of the scale would tend to blend more than the higher tones, and make the shake less distinct. Hence the observation that shakes in the upper scale are more easily perceived than in the lower, is readily explained by the new theory.

In conclusion, a few words may be added with reference to the argument that the upper partials of a tone can be perceived, therefore there must be, according to the resonance theory, separate basilar fibres set in sympathic vibration by these upper partials. In the first place, very few persons are able to hear these upper partials without the aid of resonators, and those who can hear them do so only after considerable and special training. This being the case, it seems very reasonable to suppose that the analysis of a tone is a mental process and not a physical one. Just as we can learn to distinguish the taste of one particular substance of a mixture, so we can learn to distinguish one particular sound of a compound tone. This analysis is a function of the brain—not of the sense organ, and may, therefore, be developed by training. The appreciation of melodies appears also to be a function of the brain[2].

It seems to the author that if tone perception were

(1) Helmholtz. Loc. Cit. p. 236.

(2) Alt. f. Ueber Melodientaubheit. Monatschr. f. Ohrebhlk. Berl. 1905, pp. 251-253.

dependent upon a sympathetic vibrating function of the cochlea, training would be less necessary for the perception of the fine differences, and that persons abnormally deficient in perception of harmony and discord would be less frequently met with. We would expect also to have a definite demonstrable pathological change in persons with deficient tone-perception. This does not appear to be the case[1].

The same arguments used against the Helmholtz basilar membrane theory of sound perception apply equally well to the various other theories of sound perception, such as the telephone theory, and the theory of the sympathetic vibration of the fibres of the tectorial membrane, or the theory of the longitudinal undulations of the tectorial or basilar membranes.

To sum up our investigations we see then:

1. That the anatomical and histological structures of the scala media are incapable of sympathetic vibrations, and that they never had such a function according to their phylogenetic and ontogenetic development and that there is nothing conclusively showing the existence of such a function.

2. That the complicated resonance theories are altogether unnecessary for the explanation of any of the phenomena of sound perception.

3. That our theory explains all these phenomena on a much simpler as well as a more logical basis.

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(1) Bryant, W. Sohier, Die Scheneke und ihre Verallgemeinte Empfanglichkeit fuer Toneindrucke. Arch. f. Ohrenhlk. Vol. 76, 1908.

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Discussion.

Dr. Geo. E. Shambaugh, Chicago:—The problem of sound perception is a complicated one. I do not see that Dr. Bryant has touched upon even the outskirts of the problem. As far as I have been able to make out, he has but presented a restatement of a theory advanced by Ayers a number of years ago. The theory is untenable first because it is based on anatomical conceptions which every one who has worked with the labyrinth knows to be fundamentally wrong, second because the physiological conclusions are from the standpoint of the physiologist impossible conceptions.

Now as regards the anatomical basis the assertion is that there is no membrana tectoria: that what appears to be this structure is but an agglutinated mass of hairs from the hair cells which in the process of fixing have become matted together. Any one who has seen a successful cross section through the cochlea, will see at once the absurdity of this proposition. Such a section will show an enormous number of parallel fibrills entering into the structure of the membrana tectoria with but a small number of hairs from

but few hair cells. If the fibrills of this tectorial membrane are the hairs of the hair cells how can one account for the hundreds of thousands of these in each section. Furthermore a differential stain will stain the hairs of the hair cells bright red and the fibrills of the membrana tectoria a bright blue.

As regards the physiological conception the statement is that the wave impulses from every tone sweep through the cochlea, each tone stimulating every hair cell in the organ of Corti. This is of course but a restatement of the fundamental conception in the telephone theory advanced by Rutherford many years ago; a theory which physiologists have discarded as untenable. Rutherford advanced the idea that the organ of Corti from one end of the cochlea to the other was stimulated for every tone and believed that its action in this regard was not unlike a telephone membrane. The analogy between the phenomena of hearing and that of a telephone device is however, not a true one. Suppose, for example, that three tones, a, b, and c, are sounded together before the ear; the complex arising from these three tones impinge upon the drum membrane and is transferred to the fluids in the labyrinth. Subjectively we are able to analyze the sound complex and we can recognize the three tones a, b, and c. In the telephone device the complex produced by sounding together the three tones a, b, and c, is reproduced in the distant end piece just as it entered the receiver. The telephone has no power of analysis. The analysis which we perceive while listening at the distant end piece is not accomplished by the telephone but takes place in the ear itself. A fundamental physiological objection to the theory that all the hair cells are stimulated by every tone is that such a theory requires the several fibers of the auditory nerve to carry at the same time impulses from tones of varying pitch. This would seem to be a physiological impossibility. We can conceive of a nerve carrying the impulses of a tone vibrating 64 times per second, or 2,048 times, or 20,000 times or higher; we cannot conceive, how-

ever, of a nerve fiber carrying all of these impulses at the same time.

Dr. B. A. Randall, Philadelphia:—I am one of those who can still find some comfort in the Helmholtz theory and feel that if the fibers of the basilar membrane do not sufficiently cover the matter the arrangement offered can do a great deal towards the differentiation of tone and leave a great deal less for any such fine-spun theories, which can have but little anatomical basis. With regard to the tectorial membrane, it is known that in a very early stage of the embryo, when as yet the hair cells have not developed, in each of the regions of the labyrinth which is to have hair cells there is tectorial membrane practically already present. It is the tectorial membrane of Corti, the firm gelatinous substance, in the acoustic area of the vestibule, but there it is before the hairs of the cells or the hair cells themselves are differentiated at all.

I believe that it is a mistake to try to decide this question positively from the organs of lower animals; that man's cochlea is very much more developed than that of the lower animals; that the cochlea of primitive man was as well developed as that of the educated individual. The question has not yet been met from its anatomical side at all adequately and I think there is less strain for transcendental explanations if we do not try just yet to throw overboard Helmholtz's theory of the striations of the basement membrane. Embeded as these are in a substance that is quite gelatinous, it is similar to the same gelatinous material that constitutes the tectorial membrane, and which is so sticky in fresh membrane as to make it difficult to tell from the tectorial membrane. There is a good deal yet to be studied out even in the lower animals.

Dr. W. Sohier Bryant, New York, (closing remarks):—In answer to the anatomical objection of Dr. Shambaugh, I think that I have seen these hairs of the tectorial membrane arising from the hair cells of the organ of Corti. I used

teased fresh preparations in isotonic salts solution. I think that physiological combinations of stimuli a, b and c do not occur, more than that they are transmitted by the same nerve fibres. The brain, not the peripheral organs, analyzes these stimuli.

The different effects of the 64 and 2,048 vibrations I think are transmitted through the nerve independently.

BRIEF REPORT OF TWO CASES OF SINUS THROMBOSIS.

By JOHN B. RAE, M. B., C. M., New York, N. Y.

The following two cases of sinus thrombosis are very briefly reported, because they seem to the writer to be of sufficient interest to warrant such a record—one on account of a desperate complication, and the other because of its misleading history previous to the establishment of the diagnosis.

Case 1. B. G., a girl of 13 years, was seen in consultation on November 22d, 1908. She was a thin, ill-nourished child, had never been healthy, was lame as a result of anterior poliomyelitis, and several years before, had had tubercular glands removed from the left side of the neck. She also had a foul-smelling discharge of many years' duration from the left ear. Temperature was 103°, lungs negative. Examination of the canal revealed nothing distinctive, the drum being practically destroyed and the fundus filled by granulation. There was no post-auricular edema but tenderness on pressure could be elicited over the whole mastoid, especially in the region of the antrum and at the tip. It may here be mentioned that, for good and sufficient reasons, no laboratory aids could be employed, so that the case was carried to a conclusion without a definite knowledge of the infection, of the differential blood count or of the result of a blood culture.

The child was removed to the Manhattan Eye, Ear and Throat Hospital and the radical operation was performed on the following day, November 23d. The periosteum was not adherent and, under a thin hard cortex was discovered a mass of somewhat cheesy, broken-down, ill-smelling material, the whole appearance making it probable that the original infection had been tubercular. The inner table over the sinus was completely eroded and the vessel exposed for at least

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NAME Bertha Greenbaum

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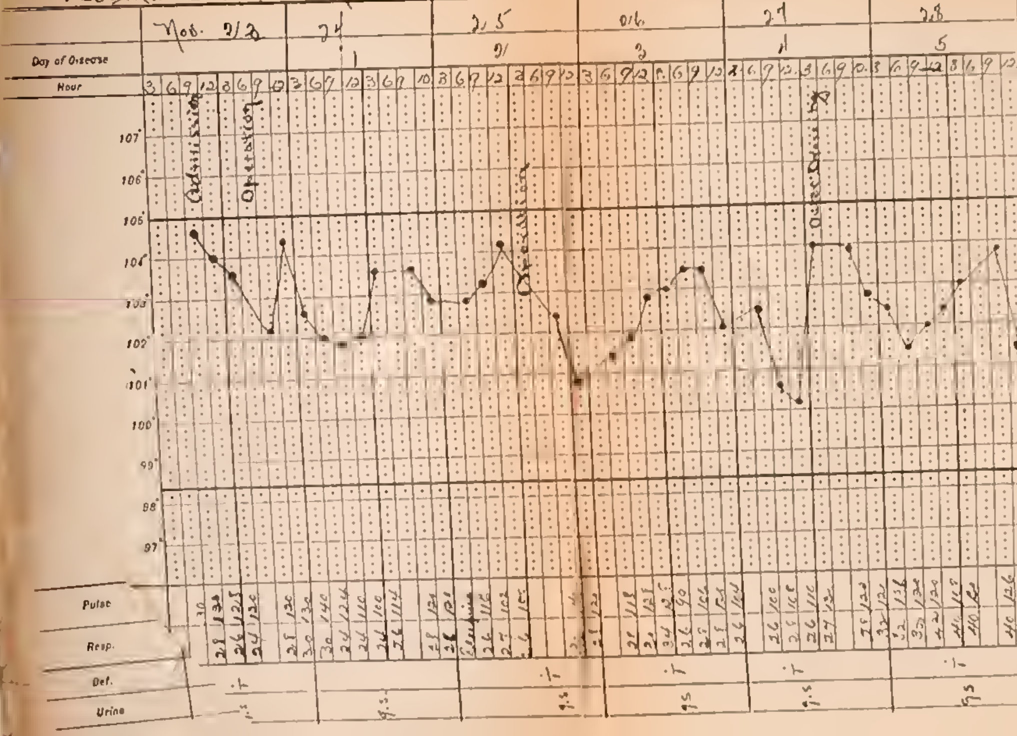

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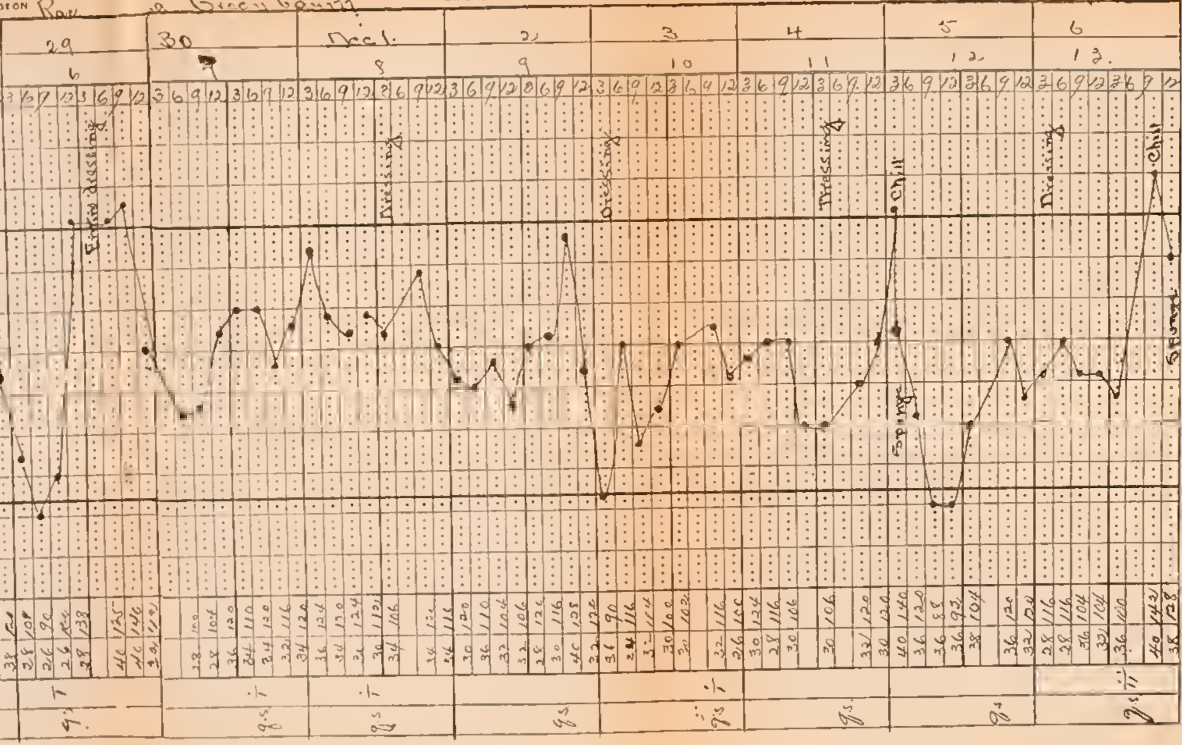

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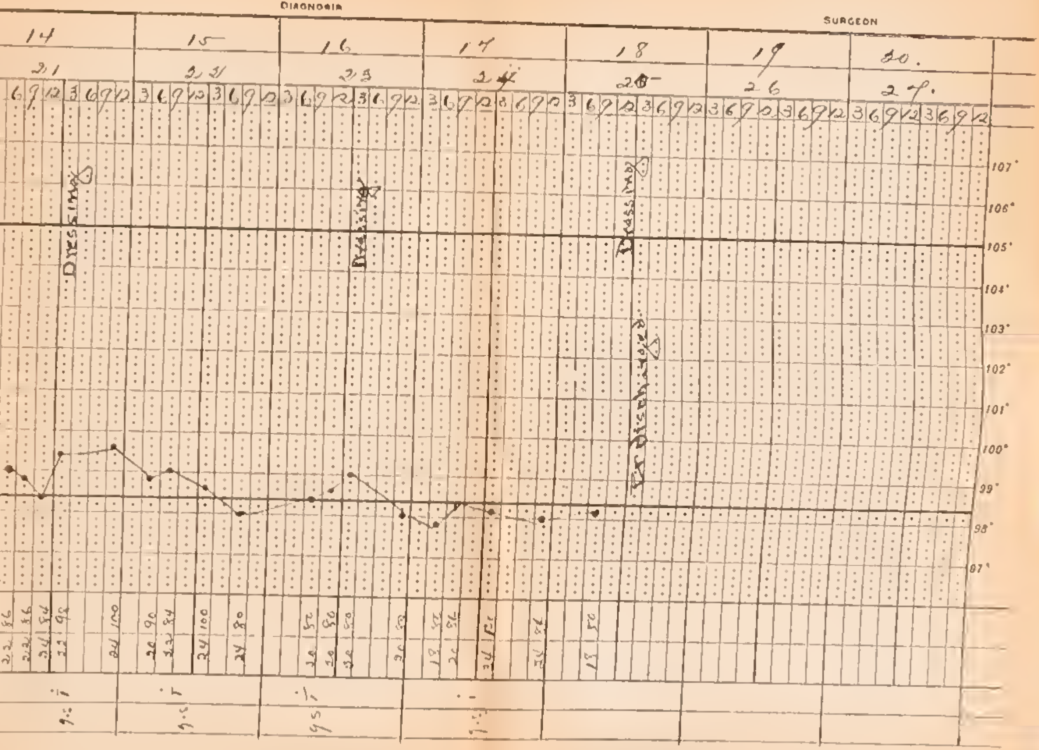

an inch, covered by granulation. No definite information as to the nature of the contents of the sinus could be obtained either by inspection or palpation. The posterior canal wall was then removed and the middle ear cleaned out, but because of the doubtful appearance of the sinus and the general condition of the patient, no flap was cut and the postauricular wound was left open.

For the next twenty-four hours there was no appreciable change in the appearance of the patient. Examination of the lungs revealed nothing. Neck signs were also negative. On the day following, the patient's condition rapidly became worse, so much so that only after most strenuous urging was permission obtained for further operation. The sinus was freely exposed and opened. The lumen was occupied by a disintegrating clot and there was no hemorrhage from either end. Without disturbing this clot the internal jugular was exposed and resected. Partly doubtless on account of the previous operation on the cervical glands, and partly on account of a present phlebitis and periphlebitis, the contents of the sheath were matted together, so that not only was identification of the vein difficult, but its removal was rendered extremely tedious. The neck wound was closed by interrupted suture with a gauze drain in the lower angle. The bulb end of the sinus was freed from clot as far as practicable by gentle curettage with a blunt ring curette, and free hemorrhage obtained from the torcular end by removal of bone and sinus wall behind the limit of the clot. The patient was returned to bed in desperate condition and stimulation applied.

The neck wound, as is always to be expected where the infection has spread into the vein, broke down, the point of ligation of each of the branches becoming a focus of infection. The advantage of the interrupted suture is evident, for on inspection of the wound, individual sutures can be removed as indication presents and drainage of small areas effected, while primary union of the wound as a whole is obtained at the same time.

The further progress of the case is best considered in association with the temperature chart. It is a well known fact that the blood is able to dispose rapidly of bacteria already in the circulation provided that the source of further supply is cut off. The conditions found on operation and the outcome of this case make the presumption fair that after the resection of the vein there was no further discharge of bacteria into the blood stream. The continued high temperature must, therefore, be accounted for from the other clinical phenomena. On the fourth day after the jugular operation the temperature suddenly rose from 98° to 105.2° and then for the first time the clinical signs of metastasis in the lung became evident. To put it briefly, there was nothing lacking to make the diagnosis of gangrene of the lung certain, the characteristic odor was present and the patient coughed up portions of lung tissue.

The temperature changes for the seven days following the first sharp rise are extremely interesting. The type was distinctly septic and the temperature ranged between 98° and 106°, the latter being recorded on the seventh day subsequent to the rise to 105°. There was a rapid drop to 99°, and no further high temperature.

From a purely clinical standpoint the conclusion seems inevitable that the temperature changes after ligation of the jugular, were not the evidence of a continued systemic infection, but are to be explained by the local conditions in the lung. Each high rise most likely marked the infection of a hitherto uninvolved area of lung, and these repeated rises ceased, and the temperature fell, almost by crisis, when the local disease became self-limited and further infection stopped.

Twenty-five days after admission the patient was discharged and three weeks later returned to the hospital when a plastic operation was undertaken and the post-auricular wound successfully closed. The middle ear is now dermatized and dry and the general condition of the patient better than it has been in years.

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This girl was the patient of Dr. Nathan B. Van Etten who directed the general treatment of the case throughout the whole stay in hospital.

Case II. C. W., a boy of 8 years, had suffered from scarlet fever three years ago. As a result, both ears had become purulent and remained so for a period of about 5 months when the discharge from both ceased. There was no subsequent aural trouble until the present attack. His family physician was called to see him during an attack of acute follicular tonsillitis. Two days later the child complained of intense pain in both ears and the writer was called in consultation and incised two bulging drums. Three days later the family physician reported by telephone that the ears were much better but that the patient was suffering from acute articular rheumatism, the left wrist joint being the only one involved. On the suspicion that sepsis and not rheumatism was the cause of the joint involvement further consultation was insisted upon.

There was considerable discharge from both ears, the left mastoid was markedly tender to pressure and there was evident prolapse of the postero-superior canal wall. The right mastoid also exhibited a slight degree of tenderness over the antrum. The temperature record was septic in character. Diagnosis of septic thrombosis of the left sinus was made. Immediate operation was advised and the child was removed to the Manhattan Eye, Ear and Throat Hospital and the operation performed the following morning. By this time tenderness had practically disappeared from the right mastoid and the appearances within the canal were better. But the right ankle joint was now also involved.

On operation on the left side a perisinus abscess was found, and on opening the sinus a disintegrating clot was laid bare, preventing hemorrhage either from the bulb or from the torcular end. Without disturbing this clot the internal jugular vein was ligated and resected. The bulb was carefully curetted and hemorrhage obtained by removal of clot posteriorly. The neck wound subsequently infected

but healed rapidly on drainage. The mastoid wound also healed kindly and at the present date the middle ear is free from discharge.

No other joints became infected after the ligation of the vein and those already affected cleared up entirely on fixation and external applications.

The blood culture made at the time of operation showed the presence of a streptococcus. The differential blood count showed a polymorpho-nuclear proportion of about 85%.

The interesting feature of this case to the mind of the writer is the perfectly natural sequence of events by which one might very easily have been misled. The association of acute follicular tonsillitis with a rheumatic diathesis has long been known. Aural complications are of frequent occurrence in children who are the subjects of adenoids and enlarged tonsils. It would, therefore, seem to be of the utmost importance that special emphasis should be laid on the necessity in just such cases as this, of making a differential diagnosis between an acute articular rheumatism and a septic synovitis or arthritis.

REPORTS OF TWO CASES OF INFECTIVE THROMBUS IN THE SIGMOID SINUS AND JUGULAR VEIN. OPERATION. RECOVERY.

By T. H. HALSTED, M. D., Syracuse, N. Y.

The two cases reported, while in many respects typical, yet present some unusual features which seem to warrant their report.

Case 1.

Anna D., German, aged 12 years, was admitted to the ward of St. Joseph's Hospital late January 20th, 1907, with a history of having been perfectly well until five days before, when the right ear began to ache. She remained home from school because of it. The earache continued to increase in severity, but her physician, Dr. Fischer, was not called until shortly before he sent her to the Hospital. Three days before admission she vomitted, and on the day of admission, before coming to the Hospital there were three slight chills. Three years previously she had an acute suppuration of the same ear, at which time the writer incised the ear drum. The drum-head healed after the discharge had continued three weeks. Since that time until the present attack, there has been no discharge, and no ear difficulty.

On admission to the Hospital, she complained of severe pain in the right ear, there was marked tenderness over the mastoid, and below the angle of the jaw, mind was clear, but earache intense. The temperature 100.6°, pulse 102, respiration 30. The interne, Dr. Hamilton, ordered hot douches to the ear, and an ice bag over the mastoid. During the night the temperature reached 103.6°. I saw her for the first time at 9 A. M. the following morning, at which time the temperature was 99.4°, pulse 84, mind clear, but intense earache. Very marked tenderness and pain on deep pressure over

the mastoid and at the angle of the jaw extending downward an inch and a half. There was distinct swelling at the angle of the jaw. The tympanic membrane was red and bulging, and the postero-superior wall of the external canal reddened.

Under Somnoform anaesthesia, a free incision of the drum-head was made, followed by a profuse flow of pus. Irrigations of hot boric acid were ordered, the ice bag continued, and orders were given to obtain the consent of her father for operation on the mastoid.

At ten-thirty (an hour and a half after incision of the drum-head) she had a chill lasting fifteen minutes, the temperature increased to 101.6°, pulse 106. At noon, the blood count showed leucocytes 15,600, temperature 104.6°, pulse 122 and severe pain in the neck. No delirium, pupils normal, no vomiting. At two-thirty P. M. under ether, I opened the mastoid, and immediately on opening the cortex there was a bubbling of gas through a rather thin yellowish pus, and an odor like sulphuretted hydrogen so pronounced that the students in the operating amphitheatre became at once cognizant of it.

A complete exentration of the mastoid down to the tip was made. The pus was streptococcus.

Following the operation the temperature did not reach 100° that night, there were no chills or delirium, and she slept very well, though complaining of pain in the head. On Tuesday, first day after operation, the temperature remained stationary, without remissions, at about 102°, pulse 100, no chills or delirium, headache steadily diminishing and no earache. Slept well Tuesday night, and on Wednesday the temperature remained at 100°-101°, reaching 102.4° at 10 P. M. No chills, slept well. Still complains of pain in the head. Bowels constipated, and Cascara and enemas given. Mastoid dressings changed during the day.

Thursday, the third day after the mastoid operation, after a fairly good night's sleep, at 6 A. M. temperature was 100°, at 12.30 noon it reached 105.4°, pulse 132, and she com-

plained of feeling cold, and seeing things when the eyes were closed. Slightly delirious, perspired freely. Diagnosis; infected thrombus in the lateral sinus, with possible extension to the jugular. Preparations for operation were ordered. There was delay and difficulty in getting the father's consent, but at three P. M. she was taken to the operating room. Temperature now was 102°, pulse 108. An incision in the neck along the anterior border of the sterno-mastoid was made, and the internal jugular exposed. After separating it from its sheath, two ligatures were passed around it and tied, and an inch of the vein resected. A thrombus containing pus was found in the resected portion of the jugular. The thyroid and facial veins were tied off. The wound was closed by subcutaneous sutures, a piece of rubber tissue being inserted for drainage. The mastoid dressings were now removed, and the bone over the lateral sinus from the knee down to the jugular bulb was removed, exposing the sinus for about an inch and a half. The dural wall of the sinus was thickened and grayish. An incision half an inch in length was made in its long axis. The sinus was found empty. The distal end of the sinus was freely curetted, removing a thrombus, and the curretting continued until there was a free flow of blood from this direction. The hemorrhage was arrested by firm tamponing, and the wound dressed.

Following the operation the girl's condition improved at once, the mind being perfectly clear the next morning, headache entirely gone, temperature varying from 99°-100°, reaching 101.6° but once within the following four days. After a week the temperature became and remained normal. The wound in the neck was closed on the thirteenth day. The mastoid wound granulated rapidly, and in four weeks had closed with the exception of a small sinus which persistently refused to heal, until it was thoroughly curetted. The wound then healed and the patient left the Hospital April 18th, 1907, ten weeks from date of admission.

Briefly, on entering the Hospital, which was five days

from the onset of the ear infection, which was streptococcic, pus was sealed up in the mastoid under great pressure, and evidence of beginning thrombus in the sigmoid sinus extending into the jugular vein, was shown by the swelling and tenderness below the angle of the jaw. Vomiting and chills occurred within three days of the initial earache, so that is probable infection had travelled within three days from the tympanic cavity to the venous sinuses. Three days were allowed to elapse between the mastoid operation and the resection of the jugular and opening of the sigmoid sinus—largely because an improvement in the child's mental condition, together with a diminution of headache and earache, made the father refuse a second operation until he was himself able to see on the third day, an increase of grave symptoms, such as chills, delirium, and high temperature. By this time, a septic thrombus had entirely occluded the sigmoid, and had extended into the jugular vein. The improvement following the second operation was immediate and permanent.

Case 2.

Ethel M., aged 17 years, developed an acute tonsillitis on July 10th, 1907, and was taken care of by Dr. A. J. Campbell. In three days she was able to be up, but on July 15th, having passed a comfortable night and slept soundly, she awakened at eight A. M. screaming with earache. I was called to see her that afternoon at Dr. Campbell's request. During the day she had taken four drams of Paregoric and an eighth grain of morphine, without any apparent effect on the pain. I found her at four P. M. with a temperature of 102°, pulse rapid, complaining of nausea, dizziness and excruciating pain in the ear. The drum-head was reddened and bulging. I incised this freely under local anaesthesia, finding pus. In half an hour the discharge was very free and the earache ceased. During the next two days the discharge was still very free, there was no earache, but much mastoid tenderness, nausea and dizziness very distressing, temperature from 100° to 102°.

Drs. Breese and Jacobson, general surgeons, saw her during these two days. The local ear condition seemed to improve during these two days, the nausea and dizziness being the most disturbing symptoms. On the morning of July 14th, four days after my incision of the drum-head, the temperature, which had been down to 100-102°, suddenly increased to 104°. The dizziness and nausea had greatly improved, but the mastoid pain which had been subsiding, grew worse. I sent her to St. Joseph's Hospital, and that afternoon, assisted by Drs. Jacobson and Breese, I did the regular mastoid operation, finding the bone inflamed, and pus in the antrum and cells. The next morning, July 20th, she seemed better, temperature lower and no earache, no headache, mind clear, vertigo and nausea better. Some suspicion of ptosis of the left upper lid and slightly dilated right pupil. During the day these eye symptoms disappeared. July 21st, Dr. Craton, an ophthalmologist, examined her eyes, finding them normal, no disturbance in the fundus. Blood count showed reds 5,120,000, whites 18,300,000, 16% small monouclear and 72% polymorphonuclear cells. Temperature at eight A. M. 102.2° and at seven-thirty P. M. 105.4°. The temperature then fell and at eleven P. M. was 101.4°. July 22nd, the temperature varied during the morning from 102° to 104° F., pulse 104 to 106. No headache, delirium or earache. Pain and swelling at the angle of the jaw increased.

A diagnosis of probable infective thrombus of the sigmoid sinus was made, but was not concurred in by all the consultants. We decided to expose the sinus, inspect it and open it if it seemed advisable. Second operation, under ether at 3 P. M., revealed a large cell, located very far posteriorily in the occipital bone and full of pus. This was cleaned out. The sinus was then exposed for an inch and a half from the knee to the bulb. The vessel wall looked absolutely normal, was compressible to the probe with no external indications of thrombus. In view of finding the previously unopened cell which was full of pus, and of the

apparent normal condition of the sinus from its external appearance, it was decided not to open the sinus but to wait for further developments. There had been neither a chill nor a chilly sensation at any time.

After the operation, the blood count showed, reds 3,780,000, whites 14.100. During the following two days the temperature fluctuated from about 100° in the morning to 104.4° in the evening, reaching 105.4° on the evening of July 24th. I had intended starting on a trip to the Pacific coast on that day, but feeling that the bottom of the trouble had not been reached, postponed it.

The next morning, July 25th, the temperature had dropped to 99.8°, pulse 96, no pain, but during the morning there was a distinct chilly sensation. The mastoid wound looked well, but there was increased tenderness at the angle of the jaw and more oedema back of the mastoid than on the previous day. Feeling certain that a thrombus existed in the sinus, it was agreed on consultation, that if the temperature should increase again, a further operation would be done. The nurse telephoned at noon that the temperature was 103° and that she had been chilly. Arrangements were made for operation, which was to be at 2.30 P. M.

On seeing the patient before entering the operating room, we found her complaining bitterly of pain in the left ankle and right elbow, which had been going on for an hour or two. My belief then was, that the thrombus had begun to disintegrate.

Third operation, under ether, assisted by Dr. Jacobson. The neck was first scrubbed and prepared, and I then made an incision anterior to the sterno-mastoid muscle, disected down to and ligated the internal jugular in two places, excising two inches and a half of the jugular vein. The ligature of the jugular was difficult because of a large goitre. The wound was then closed by subcutaneous sutures. The mastoid dressings were now removed, the wound cleaned out, and an incision an inch in length made

in the sigmoid sinus. This was immediately followed by profuse hemorrhage, showing the sinus was not walled off completely. A small curette was now rapidly introduced into the bleeding vessel, and a thrombus an inch in length was removed. The hemorrhage was arrested by tamponing. The wound was now packed with iodoform gauze, and the patient left the table in very good condition. At 8 P. M. she was feeling better than in several days, excepting for the pain in the ankle. Temperature was 102°. Antiphlogistine was applied to the ankle.

I left the city that night to be gone six weeks, leaving the patient in care of Dr. Jacobson. She was under his care from July 26th, to August 1st, when he left for his vacation, leaving her in Dr. Flaherty's care.

July 26th, first day after last operation, morning temperature 101°, evening 104°.

July 27th, temperature 102-104°. Distinct chill lasting fifteen minutes. At eight P. M. temperature 106.4°, following which 20 c. c. Stearns streptolyptic serum was given. At ten-thirty P. M. temperature dropped to 102.4° but at midnight reached 104.4°.

July 28th, 8 A. M., temperature 98.8, pulse 104. She was given 10 c. c. of serum every six hours. At eleven A. M. blood count showed 28,800 whites.

July 29th, temperature varied from 102.8 to 104°, pulse from 110 to 124, blood count showed whites 18,100. The serum was continued in doses of 10 c. c. every six hours. Pain in ankle less and no new disturbance.

July 30th, temperature at midnight was 102.6°, dropping to 100.8° at nine A. M. Mastoid dressings were changed.

The patient now came under Dr. Flaherty's care.

On August 2nd, eight days after the last operation, the ankle was improving, temperature remaining down to about 100°, but on August 4th, there was an increase of temperature to 104.4°, the ankle looked red and angry, and it was feared it would have to be opened.

August 7th, there was a discharge of about four ounces

of pus from the wound in the neck; following this a rapid improvement in every direction.

August 24th, she left the Hospital with wound in neck healed, and mastoid almost entirely filled in. The left ankle swollen and leg somewhat oedematous. On September 3rd, when I returned home I found her practically well: the mastoid granulating, drum-head closed, and wound in neck closed. On October 1st, ten weeks after her last operation, the mastoid had entirely healed, the swelling of the ankle was rapidly diminishing. The ankle became normal two months later. The hearing on the affected side is entirely gone both for bone and air conduction. There is no vertigo.

In this case, streptococcic infection began as an acute tonsillitis, rapidly extending to the tympanic cavity and early invaded the internal ear. The tympanum was freely incised within eight hours of the first pain in the ear, streptococcic pus filling the cavity; within four days the mastoid was opened and exentrated, pus being present throughout. Two days later the symptoms all pointed to a sinus thrombosis, but a difference of opinion among the consultants resulted in a compromise in the nature of the second mastoid operation and the sinus was merely exposed and not opened because it was thought the symptoms might be accounted for by the presence of a newly discovered large cell full of pus in the occipital bone posterior to the mastoid. Chills and chilliness were conspicuously absent until the thrombus began to disintegrate.

The third operation, excision of the jugular and opening of the lateral sinus was made three days after the second operation or nine days from the beginning of the ear infection. The thrombus had just begun to break down and immediately before this operation infective portions had been carried to the ankle and elbow. It was a case where a matter of a few minutes made all the difference between life and death.

The excision of the internal jugular was made very difficult by the presence of a large goitre, and the goitre

later masked the presence of an abscess which formed in the neck, possibly because all the infected jugular vein had not been excised.

It seemed probable that the streptolyptic serum was of value, although the spontaneous evacuation of the cervical abscess was the beginning of the later uninterrupted recovery.

Discussion.

Dr. Edw. B. Dench, New York:—There is one point in Dr. Rae's paper I would refer to, that is the use of the interrupted suture. I quite agree with him as to the value of these sutures for closing the wound in the neck. I should like to ask him if he has ever used the little metal clamps, which have all the advantage of the interrupted suture and which save time?

Both Dr. Rae's cases and the last one reported by Dr. Halsted with reference to articular rheumatism remind me of two cases seen some years ago. In the first case there were typical symptoms of mastoid involvement but operation could not be done because of the existence of pneumonia. The second case was interesting because there was a question as to diagnosis. The patient had acute otitis media. Both membranes were incised and the temperature fell; both membranes cleared up. The ears remained dry for ten days, when his physician telephoned me that he had a temperature of 101 and seemed drowsy. He was brought to New York at once. There was no recurrence of the trouble in the ears; no tenderness along either jugular vein. The boy as he stepped from the train complained of severe pain in the right metacarpal joint. He had an attack of acute rheumatism from which he recovered. A blood culture would have helped out in this diagnosis. The fact that the ears had healed would not of course preclude the possibility of sinus involvement.

Dr. J. F. Barnhill, Indianapolis:—The question of difficulty in diagnosis in these cases has been referred to. About a year ago I had one of these cases of extreme difficulty. A young lady was sent to the hospital with double mastoiditis and a temperature of 103. Both mastoids were cleared out very rapidly because of the serious general condition of the patient. She did not recover rapidly, ran an irregular course as to temperature and it soon became evident that there was sinus thrombosis; but since both sides were exactly alike as to the diseased condition of the mastoids it was impossible to tell which sinus might be affected, and I do not know today how anyone under these circumstances could make a positive diagnosis. It was evident that the patient would die if left untreated, so we made an exploration on one side and fortunately found a thrombus which was cleared out, the patient thereafter making a speedy recovery.

Dr. Percy Fridenberg, New York:—Was any ophthalmoscopic examination made in this case of Dr. Barnhill's? I do not mean that finding of choked disc on one side or the other would definitely prove the diagnosis of thrombosis but it would weigh in the balance as to whether the operation upon the sinus was to be done on one side or the other.

Dr. Norval H. Pierce, Chicago:—Last winter I was called in to see a child six years of age who had earache three days before and a paracentesis had been performed immediately and when I saw the child there was swelling over the mastoid and a temperature of 103. The parents were averse to operation and the men in charge were not all together for it and I gave consent to wait until further mastoid symptoms should develop. I was again called that evening and the child had had chill and temperature of 105. That night the mastoid was entered and along the wall were quite large cells filled with pus. The wall of the sinus, however, appeared healthy and there was no evidence of thrombus on palpation. I was present at the operation, which was

brought to an end and the patient returned to bed. Everything went well for two days, when at eleven o'clock at night I was called with a notice that the patient's temperature had gone up to 106 preceded by a violent chill. I went to the hospital and exposed more of the sinus but could not find any evidence of thrombus at all. I opened it, however, and a violent hemorrhage occurred from above and below. I tied the jugular, dissecting it out up to the bulb, and was unfortunate in injuring the facial vein, which seemed extremely firable. The child sustained these insults and although we had to work over her that night with salt injections and strychnia, she gradually resumed consciousness and ultimately recovered.

Another case illustrates the difficulty of deciding which mastoid to operate on. Dr. Shambaugh saw this case also: that of a young child with suppurating ear for some weeks, during which time there was aseptic temperature and at times the nurse thought there were chills. Leucocytosis was elevated, but, because we could not say which mastoid to operate upon first or whether both, the father took the chance and the child recovered nicely without any operation.

Dr. Charles W. Richardson, Washington:—I had this winter two cases that demonstrate the difficulty of diagnosis very prettily. One was a child that had scarlet fever and the fifth week after the disease, the temperature having been normal for a week, shot up to 104 and then there was a distinct septic temperature, the highest being 105 and the lowest 97. I saw the child on the seventh day after this condition had existed. There was very little mastoid tenderness and the question arose as to whether there was a thrombosis or not. I was rather of the opinion that there was not. I did a mastoid operation and found hardly enough pus in the mastoid to call it such. The antrum contained a quantity of granulation tissue. The temperature the night I operated was 106.2 and went down from that to normal and continued so.

On the other side, the day afterward I operated on another case, that of a young man who was perfectly well on Tuesday when he became infected with tonsillitis; on Thursday afternoon he had some pain in his right ear; on Friday morning the membrane ruptured; on Saturday I operated on him and found a thoroughly infected mastoid, there being pus even in the posterior cells. He continued after that with almost normal temperature for four days. On the fourth day his temperature was 100; next morning 100 and then it went up gradually to 104, where it remained for three days. There was some question as to the condition, for he had also had when operated on a distinct erethema and the question arose as to whether it might be scarletina. I had a health officer inspect the case and he said it was not scarietina. Blood count showed whites 22,000. On the fourth day I decided that there was probably a thrombosis which warranted operative intervention. I operated and found a clot, and ligated the jugular vein. The case went to the bad and patient died in about ten days. Now, the first case which looked like a case of thrombus but was not; the other looked like it was not thrombosis and it was.

Dr. Wendell C. Phillips, New York:—A word of caution should be given, especially to the younger men, as to operating on the sinus and tying the internal jugular after mastoid operation simply because of a sudden rise in temperature with vomiting and chill, because there are conditions which may arise and lead to that series of symptoms. I would refer to a woman who had very extensive mastoiditis and at the time of operation considerable exposure of the lateral sinus the necrosis was so extensive. Two days later her temperature arose to 105 and she had a chill and vomited. The next morning there was a remission and about noon the next day the temperature reached 105 again and she had optic neuritis. I opened the lateral sinus and there was nothing in it. She was placed in bed and by the next

morning there was a very fine development of erysipelas of the original wound.

As to technique I had an experience where in making haste in operating to get beyond the clot in the internal jugular vein my assistant accidentally wounded the innominate vein and there was tremendous hemorrhage. I only report this to tell how we controlled it. We each had an ordinary gauze wipe and immediately stuck it in and held it there, long enough to get fresh gauze, which we forced in more and more until we simply packed it off by force. The patient went into collapse but we gave normal salt injection and he came around and lived over three weeks after that time. He had a general sepsis from which he died.

Dr. J. B. Rae, New York, (closing remarks) :—I think Dr. Dench's suggestion as to the metal clip sutures is a very good one.

As to Dr. Barnhill's difficulty in deciding which sinus to open, each one of us must sometimes encounter that difficulty and I do not know of any way to decide it. Both sinuses should be freely exposed when some definite indication may be discovered either by inspection or on palpation. As a last resort—and bearing in mind the danger of dislodgment of clot, each sinus in turn may be emptied of blood by pressure with the fingers. Release of pressure first at the torcular end of the exposed sinus, and later at the bulb end, will at least show whether the sinus fills with blood satisfactorily.

With regard to Dr. Phillips' case of erysipelas, the blood culture might have been of value from the negative point of view.

Dr. Thomas H. Halsted, Syracuse, (closing remarks) :—In my second case we had two general surgeons in consultation and it was difficult for them to appreciate the possibility of thrombosis of the lateral sinus extending so quickly and it was with difficulty that we got the operation.

THE CLINICAL AND PATHOLOGICAL SIGNIFICANCE OF BACTERAEMIA IN SUPPURATIVE OTITIS.

By ARTHUR B. DUEL, M. D., and JONATHAN WRIGHT, M. D.,
New York.

The clinical and microscopic study of the blood in health and disease, during the past 20 years has been of inestimable value in establishing the diagnosis and prognosis of many conditions which had hitherto been doubtful.

One has only to recall the uncertainty in malaria, typhoid, leukaemia, etc., previous to such examinations to appreciate their importance. So too the great value of differential leucocyte counts in estimating the gravity and extent of purulent infections has been well demonstrated.

Although the study of larger quantities of blood, by culture methods in different media, is more recent; and the results, naturally, from the comparatively limited experience, of less certain significance, it bids fair to throw much additional light on morbid conditions.

Dr. Wright, who has joined me in the preparation of this paper, and in the discussion of the problems presented by the work done in the clinic, and in the laboratory, remarks: "The idea that clot formation somewhere in the body must be present to form a nidus for the bacteria circulating in the blood, is not borne out by theory, or observation, or experiment, as noted in recent work. Fraenkel[1] for instance explains the occurrence of thrombi from infection of wounds at that time of operation, also from distension of the intestines, letting the infectious agents through; also in anginæ.

The idea here is, undoubtedly, that minute clots in the veins form a culture medium in the wound for infecting

(1) Ueber post-operative Thrombo-Embolie: Archiv fur kli. Chirurgie B-d. 86. 1908. Ref Centrlblt f, allg. Pathologie &c, XX B-d. No. 4, 27 Feb. 1909.

bacteria. This is noted in abdominal work, but since they accompany anginæ, and intestinal distension, and other conditions of trifling import, and, since our experiments show that they are concomitant with slight systemic disturbances accompanying middle ear suppuration, it seems reasonable to suppose, from these and many other similar facts, that the blood clot has little to do at least, with the sporadic occurrence of bacteria in the circulation. The initial disturbance is probably a systemic one, which may let the bacteria through, from the surface,—as operative shock, or cold catching, etc. It is still more evident that nervous shock of various kinds, including that from operative proceedures, loss of blood, etc., frequently overturns the equilibrium existing between a streptococcus, or other pathogenic agent, present in the blood without signs, whereupon the obvious and sometimes threatening symptoms of septicæmia, develop. I think this is the only view consistent with what we know of the extremely frequent saprophytic existence of the tubercle bacillus in the human organism. The same support may be found in the numerous instances of those carrying typhoid, diphtheria, and cholera bacilli in the circulating blood. A like support can be found in the literature of latent microbism of the lymph nodes[2].

I need specifically to refer to two more quotations only in my notes bearing on the subject: 1. When mice were experimentally fed with a bacillus of the paratyphus group[3]. "In the circulating heart blood the bacteria could be repeatedly demonstrated at a time when the mouse was still entirely healthy." "When the mouse became sick it was then first found in the intestinal canal."

2. "Out of the blood of two women typhoid suspects (during an epidemic of typhoid) the typhoid bacillus was repeatedly cultivated. These patients did not have typhoid,

(2) See for instance Dudgeon and Ross Journal of Bacteriology March 1906. Dr. Reiner Muller: Centralblatt fur Balteriologic xl No. 5, P. 620, March 10, 1906. Conforti and Bardoni: Ibid. For full literary reference, see Wrozek: Virchows' Archiv 178 P. 83.

(3) Marks L. H. Arbeiten aus d. Inst. f. Exper. Therapie zu Frankfurt A. M. 190.

nor was there any history of their having had typhoid, but autopsy revealed miliary tuberculosis. Another case of a man with phthisis showed typhoid bacilli in the blood.'' The author[4], from whom I quote, remarks very pertinently to our subject, ''The blood diagnosis, therefore, is not trustworthy in this respect.''

Prof. Rosenberg, of Philadelphia, at the meeting of N. Y. Co. Society at the N. Y. Academy of Medicine, recently reported several hundred cases of tuberculosis where in all types tubercle bacilli were found free in the blood current.

At the meeting of the New York Academy of Medicine in March of this year Dr. Emil Gruening[5] read a most interesting report of ten cases of mastoidis complicated by septic lateral sinus thrombosis in which Libman, the pathologist to Mt. Sinai Hospital, had found in seven cases the presence of a bacteræmia. Two of these cases presented no definite clinical signs, other than the history of an otorrhœa, and streptococcæmia. A septic clot was demonstrated in every case on opening the sigmoid sinus.

Based on this experience, added to that of a large number of negative findings, Libman stated his belief that, in a case of suppurative otitis, in which there was no active purulent focus elsewhere (like pyelo-nephritis peritonitis, etc.), the presence of a bacteræmia was sufficient evidence of septic lateral sinus thrombosis to justify immediate operative interference, even in cases where other definite clinical manifestations were absent.

Realizing the immense advantage of this comparatively easy method of positive diagnosis in doubtful cases (where statistics have proven that operative interference, when adopted within the first week, has saved twice as many patients as when adopted after that time), the authors attempted to substantiate or disprove this position, from the large material offered by the Manhattan Eye, Ear and Throat Hospital. All of the attending surgeons courteously con-

(4) Busse: Munchener Medizin Wochenschrift, 1908, P. 1113.
(5) N. Y. Medical Record.

sented to the examination of suitable cases admitted to the hospital wards on their respective services, and we are therefore able to present the result of a large number of cases in a comparatively short time.

In all, from February 27, 1909, to March 15, 1909, at the time of this writing, cultures have been made from fifty-seven patients:—55 ear cases from the clinics of Berens, Phillips, Duel, McKernon, and two frontal sinus cases, from the clinics of Chappell and Coffin. In some of the positive cases, one or two repeated cultures were made to confirm the first.

Owing to the difficulty in making them, cultures in infants and small children were not attempted. At first only cases just operated, or about to be operated for mastoiditis were examined. Later on, cases of acute otitis, in which symptoms cleared up rapidly after myringotomy, were investigated.

In 42 of these cases the following technique was adopted by Miss Gignoux, who did all the laboratory work. "10 c. c. of blood drawn with sterile syringe or "mosquito" from the median vein is transferred to the Erlenmeyer flask, containing 150 c. c. of broth (either plain broth or 1% dextrose) and is then incubated for 36 hours at 37° Centigrade. It is then thoroughly shaken, its neck well flamed off, and 15 c. c. of its contents poured out into a previously sterilized centrifuge tube. This tube full of blood broth is then immediately centrifuged for 15 or 20 minutes; the supernant liquid is poured off and agar slants are inoculated from the sediment. This inoculation should be made with a stiff platinum loop and plenty of the blood corpsules at the very bottom of the tube should be picked up and carried on to the agar."

In these 42 cases by this method, 15 positive cases of bacteræmia were demonstrated. In a second series of 15 cases, the blood was mixed with an oxalate of ammonium solution, to prevent coagulation, and immediately plated. By this method one positive case was demonstrated.

Brief histories of these positive cases will be interesting:

No. I. No. 520630, Dr. Duel's Clinic; operated by Dr. Kerrison. Male, 37. Acute mastoiditis. Operation subperisteal pus. Pus and granulations found throughout mastoid. Temperature never above 100 F. Discharged from hospital 13th day. Uninterrupted recovery. Smear from ear showed extracellular diplococci.

Blood culture: (1st) Short-chained streptococci, on day of operation, and (2nd) Same two days after operation.

No. II. Hospital No. 521978, Dr. McKernon's clinic. Male, 22. Acute mastoiditis of one month duration, operated on by Dr. Rae. Soft parts œdematous, mastoid softened and destroyed by necrosis. Sinus accidentally punctured with thumb forceps near bulb. Temperature not above 99.4 F after operation, except for one day, until the 8th day when it went to 105.4 F. Evidence of systemic infection followed; jugular excised on 13th day after primary operation, no clot demonstrated; sinus opened and bled very profusely.

Blood culture: 1. At first operation long streptococci (Feb. 26). At second operation short streptococci (March 12). Pneumonia and pleurisy after last operation, temperature varying from 101° to 104° for twelve days after excision of jugular. Ultimate recovery. Blood count made before last operation: Leucocytes 12000; Polyneuclear neutrophiles 85%.

No. III. No. 522798. Dr. Duel's clinic. Male, 22 years. Acute mastoiditis, duration 10 days. Operated on by Dr. Duel, pus and granulations throughout mastoid. First day after operation temperature went from 99 to 106.2. Patient isolated on account of suspicious œdema and redness about wound. This subsided in 24 hours. Temperature fell gradually but varied between 99 and 104 for six days. He then had a chill and rise of temperature to 105.2. Jugular ligated and excised above the facial: no clot demonstrated. Sinus was opened and bled freely. On third day after operation temperature went to 103 but subsided and became

flat shortly afterwards. Discharged on 24th day after first operation.

1st: At first operation negative (March 10); 2nd: long streptococci (March 13); 3rd: at last operation long streptococci (March 19).

No. IV. No. 522594. Dr. McKernon's clinic. Male, 43 years. Acute mastoiditis. Short duration. Operated by Dr. Rae. Uneventful recovery. Temperature never above 100.

Blood culture: Pneumococcus.

No. V. No. 523093. Dr. McKernon's clinic. Male, 23 years. O. M. P. C. with Polpi—duration since childhood, complains of pain in knee joint (its condition not noted). Operation, Radical mastoid by Dr. Haskin. Sinus exposed, not injured, condition of mastoid not noted. Temperature after operation varied daily from 98.6 to 102.2 for six days.

Blood culture taken on fifth day after operation: Pneumococcus found. Temperature became practically normal, no further operation. Patient discharged on eleventh day after operation.

Blood culture: Pneumococcus.

No. VI. No. 523238. Dr. Coffin's clinic. Male, 28. Frontal sinusitis. Operated by Dr. Hubbard. Gradual rise and fall of temperature from normal to 102 for four days; practically flat afterward. Uneventful recovery.

Blood culture: Streptococcus.

No. VII. No. 524664. Dr. Berens' clinic. Male, 34 years. Acute mastoiditis, duration three weeks. Operated on by Dr. Braun. Pus and granulations throughout mastoid. Flat temperature following operation; no evidence of systemic infection.

Blood culture: Short streptococci. Discharged on seventh day.

No. VIII. No. 525678. Dr. McKernon's clinic. Male, 20 years. Acute mastoiditis. Duration one week. Operated by Dr. Brown. Pus and granulations throughout with softened bone. After recovery from anæsthetic chill and

rise of temperature to 104.2; gradually subsided to normal on third day. Recovery uneventful. Discharged on the 19th day.

Blood culture: 1st: Short streptococcus; 2nd: Same.

No. IX. No. 525817. Dr. Berens' clinic. Female, 18 years, O. M. P. A., two weeks' duration. Myringotomy under gas by House Surgeon. Ear irrigated every three hours. No pain, no mastoid tenderness. Temperature normal. Discharged on fifth day.

Blood culture: Short streptococci.

No. X. No. 525874. Dr. Duel's clinic. Female, 30 years. Acute mastoiditis. Ten days' duration. Operated on by Dr. Duel, pus and granulations throughout mastoid. Uneventful and rapid recovery. Temperature gradually subsiding from 102 directly after operation until day of discharge on seventh day.

Blood culture at time of operation: Staplylococcus.

Taken day before discharge: Short streptococcus.

Mastoid pus smear: Short streptococcus .

No. XI. No. 426531. Dr. McKernon's clinic. Male, 34 years. Acute mastoditis. Operated by Dr. Rae. Recovery uneventful. Temperature practically normal after operation. Discharged on sixth day after operation.

Blood culture: Short streptococcus.

No. XII. No. 526355. Dr. Berens' clinic. Male, 35 years. O. M. P. A. Myringotomy on first day of pain. Uninterrupted recovery.

Blood culture: Short streptococcus.

No. XIII. No. 526350. Dr. Chappell's clinic. Male, 30 years. Frontal Sinusitis. Admitted April 14th. Temperature normal. Operated by Dr. McKenty, April 16th. April 18th temperature rose to 102.4 and fell rapidly to normal. Complained of headache and pain in back of neck. April 19th temperature rose to 105; wound was reopened under chloroform; lumbar puncture; large quantity of turbid fluid obtained. Temperature continued high, reaching 106 on April 21st, when patient died.

Blood culture: Long streptococcus.

No. XIV. Dr. Duel's clinic. Operated by Dr. Duel. Female, 23. Rapid infection of mastoid without early noticeable involvement of middle ear. Definite signs of acute labyrinthitis following mastoid operation. Acute lepto-meningitis and death. Autopsy confirmed diagnosis. Sinus not involved.

Blood culture: Streptococcus.

No. XV. No. 527103. Dr. Duel's clinic. Male, 34 years. Acute mastoiditis. Duration 10 days. Drum membrane white but mastoid very tender. Operated by Dr. Duel. Extensive involvement of mastoid with erosion of sinus wall. Internal jugular ligated cut above facial and not excised—sinus then incised and cloth extending into bulb removed, free bleeding from above; none from below. Recovery uninterrupted; general condition always good. Temperature never above 100.2.

Blood culture: Streptococcus.

No. XVI. Dr. McKernon's clinic. Operated by Dr. Rae. Boy, 8. Operated for mastoiditis. Rapidly developing clinical signs of sinus thrombosis. Jugular incised. Sinus incised and septic clot removed. Recovery.

Blood culture: Streptococcus.

We have, then, demonstrated a positive bacteræmia in sixteen cases out of fifty-seven examined. Four cases had definite clinical signs of septic sinus thrombosis, for which jugular ligation and excision, and opening of the sigmoid sinus was performed. (Two with demonstration of clot; two without, on account of violent hemorrhage; recovery in all). One case had acute suppurative labyrinthitis and acute diffuse lepto-meningitis. One case had acute purulent otitis without mastoid involvement. Two cases from the throat clinic had frontal sinusitis, one of which was complicated by meningitis.

The remaining nine cases were those of mastoiditis without complications, each of which ran an uneventful course, after operation. Streptococci were present in fourteen of the cases—pneumococci in two.

It is significant that streptococcæmia was present in all of the cases presenting clinical symptoms of sinus thrombosis, and in the case of diffuse lepto-meningitis; however, it is none the less significant, from another point of view, that in nine cases without any alarming symptoms of further complications, seven had streptococci, and two pneumococci, in the blood.

It seems perfectly evident that a bacteræmia occurring in the course of a purulent otitis can by no means be considered sufficient cause for invasion of the sinus in the absence of other definite clinical symptoms.

The fact that Libman found a bacteræmia in seven out of ten of Gruening's cases, and that we found it in all cases in which the clinical symptoms were pathognomonic of sinus thrombosis would seem to make it a valuable additional sign in connection with other definite clinical symptoms.

A review of the histories and charts of the forty-one cases of mastoiditis in our series in which blood cultures were negative reveals the interesting fact that many of them showed temperatures and passed through a much stormier course subsequent to operation than the nine cases which showed a bacteræmia without other symptoms.

Dr. Wright in remarking upon the facts which I have adduced from our work in the laboratory adds:

"The technique of inoculating broth with 10 c. c. of blood and incubating it for two or three days and then centrifuging it is one which has proved very efficacious in demonstrating that in a large proportion of cases, with trifling symptoms of otitis, there is at least, in these cases (nearly 30%) one or more streptococci in 10 c. c. of the patient's blood. As this quantity of blood is only something like a thousandth part of all the blood, it naturally follows that the proportion of cases actually having bacteræmia must be much higher than our figures indicate. That Miss Gignoux made no mistake in the basis which she offers for this view seems probable, since, aside from the care she exercised in the technique, a certain number of the cases were examined

more than once and the same organism, so far as we could judge, was found each time. Where smears from the mastoid were compared with the culture results, there was a significant coincidence.

By **plating the blood** direct, and counting the colonies without doing so much to break up any physico-chemical inhibitive influence, the red blood cells may have on the micro-organisms in the circulation. It may well be urged by those who have persistently obtained negative results by this method, a surer indication is obtained of the systemic relationship of the patient to the infecting organism.

We have begun a series of cases using a mixture of the blood in an oxalate of ammonium solution to prevent its coagulation and then immediately plating. Miss Gignoux has obtained some positive results, one in a simple case requiring only paracentesis and showing thirty-nine colonies of streptococci, which would seem to indicate, so far as it goes, that the ammonium oxalate solution is in itself capable of breaking up any such physico-chemical combination as may exist, if there is anything in this view of the matter. After establishing these two facts and at the present writing the latter series of cases needs extension, it will remain for us to repeat the technique of other observers.

We are able through the courtesy of Dr. McKernon to report four other postive cases of bacteræmia simple mastoiditis, in which there was no clinical evidence of sinus involvement. Recovery was uneventful in all.

The blood culture in two of these was made from Sondern's Clinical Laboratory, where the technique observed includes culture by plates as well as in Erlenmeyer flask.

The other two were made by Henry T. Brooks, Pathologist to the Post Graduate Hospital and Medical School. He uses practically the same method as Miss Gignoux, but does not centrifuge.

At least we have proved that a bacteræmia does exist in such mild cases. Naturally **all its limitations have not yet been investigated.**

Discussion.

Dr. Libmann, New York:—I would like to ask Dr. Duel what the type of organism was which was found in the last four cases.

Dr. Duel:—The long streptococcus.

I find, so far as I can see in Dr. Duel's work a remarkable confirmation of our work. He found the long streptococcus only in the cases of thrombosis or leptomeningitis; that is exactly our experience. Dr. Wright and Dr. Duel let us know their technique and we studied forty cases in this way and the results were exactly the same as by our method. Among these were seven cases of mastoid disease. Our method is a little more elaborate. There is one point, and that is, that it is essential to have long experience, and it is difficult to judge of others' results. I speak of the examination of 2,000 cases of fever. Before we proceeded to the study of the systemic infection we studied the bacteriology of otitis media itself in 277 cases and found in 81% the streptococcus, and in 8% the pneumococcus. The earlier authorities stated that the pneumococcus was the more commonly found organism. It is necessary to know that the streptoccus mucosa is closely allied to the pneumococcus. Notwithstanding the fact that the pneumococcus was found so often by observers there are hardly an records in the literature of sinus thrombosis being due to it.

The methods must be carefully studied out. We are using the method established by Berger and Hess. We have recently introduced the bile method. One interesting point is that Burger and Rittenburg found that in some cases the pneumococcus is so changed in the blood as to be with difficulty distinguished from the streptococcus, but we have studied that from that standpoint and have not been able to reconvert it into the pneumococcus.

Our studies show that cases in which streptococcus are

found in the blood after operation on the mastoid and in which clinical symptoms persist are cases of sinus thrombosis.

A positive blood culture is valuable when there is doubt as to the existence of sinus thrombosis after the mastoid operation has been done. Where the mastoid disease has been thoroughly dealt with and the clinical symptoms still persist the finding of the bacteria in the blood gives an indication for exploring the sinus and in every case of this kind a thrombosis was found.

In certain cases after the sinus has been explored and the culture removed and the jugular vein not ligated the persistence of the streptococci has given an indication to tie the veins and in almost all the cases the bacteria then promptly disappeared from the blood. While the bacteraemia promptly disappeared the clinical symptoms do not always promptly abate. The fever may continue due to local conditions in the wound or to some other disease, so the clinical manifestations do not always clear up at once.

The most valuable field is in the border line cases, in which it is difficult to arrive at a definite conclusion without such cultures.

These data are sufficient to show the importance of continuing these investigations and we hope that men in the position to do so and with a large amount of material will take up this work and see if they cannot confirm it.

Dr. Emil Gruening, New York:—It has been my privilege to have Dr. Libmann associated with me in my work at the Mt. Sinai Hospital but I wish to emphasize that in all the work that I did the clinical diagnosis of thrombosis was made before the blood cultures were taken for me. So that in all these cases the otologist made the diagnosis by the clinical symptoms and I will not say here, in spite of the brilliancy of this paper, that it was absolutely necessary or that I was guided by the blood findings.

Dr. Libmann, who is the bacteriologist at the hospital, and

also an internist, in two instances transferred two of his patients, whom I had not examined, to my department. He had by exclusion made the diagnosis of sinus thrombosis without examining the ear. He said: I have excluded everything—I find streptococci in the blood—now if you find the ear diseased will you please open the sinus, and in both cases I found a thrombosis and ligated the jugular in one case. This demonstrated to me the great value of the blood cultures, especially as we also had our ordinary cases of otitis examined by the doctor and no such report had been made. I will say then that in the ordinary case blood cultures do not seem to be necessary, and our clinical methods are sufficiently good. I found sinus thrombosis also in one case in which the blood culture was negative, and this case died; my cases in which blood culture was positive and where the streptococci were found in the blood and the jugular vein ligated, recovered.

Dr. James F. McKernon, New York:—Shortly after Dr. Libmann first read his paper, I started a series of investigations in the hospitals, with which I am connected, along the lines mapped out by him. Two bacteriologists have carried out my series of experiments. We have found several cases where a bacteraemia was present following a typical mastoid operation, both in adults and children, cases which did not run any post-operative temperature. In some of the cases bacteraemia was found to exist prior to operation, and in at least three it was found to persist for several days following the operation, where no evidence of any involvement of the sinus existed and where a perfect recovery resulted. Some of the cases, however, that showed distinct evidence of profound systemic infection, had a bacteraemia prior to operation, and at operation the sinus was found to be involved. In these cases the blood was examined three times at intervals of two days, and a streptococaemia found to be present each time, though not as pronounced as at first. In some of the other cases where the

mastoid was opened without any evidence of involvement of the sinus at the time, but where later evidence of such involvement developed, the presence of a bacteraemia was, without doubt, of great value in determining the diagnosis, and so avoiding any delay in waiting for classical symptoms.

At present I would be loath to go into the sigmoid sinus without clinical evidence to back up the blood examination. I believe it would be unsafe. I think we can get our clinical evidence sufficiently to recognize the presence of a beginning involvement of the blood current. It is, I am sure, a great help to us and I think it will be of considerable advantage, but in the absence of clinical symptoms I would not go ahead and open the sinus.

One of the cases was a child one year old; one 15; and two over 30. They were operated on. There was flat temperature afterwards and still they ran a bacteraemia.

Dr. Libmann spoke of one case I saw with Dr. Whiting where the blood culture was negative and a thrombosis shown at operation. It was very distinct and yet there was a negative culture. I hope that at some future time Dr. Libmann will give us his experience as to why such conditions occur. In one case where blood culture was negative, in a child two years of age, that I operated on for meningitis and which died, the blood culture was negative throughout and we watched the case for eight days.

I understood Dr. Libmann to say that it was rare for systemic infection to take place from the gums of teeth. I have been a victim of that myself. I had an infection two or three years ago of the upper jaw; had a blood culture taken and was told that there were streptococcaemia in the blood.

Dr. A. B. Duel, New York, (closing remarks):—I regret that Dr. Wright is not here to take up the discussion of the presence of bacteraemia in these cases, inasmuch as I hardly feel justified in entering into some of the problematical ele-

ments. I feel so convinced from our studies that clinically it would be an unsafe proceeding to investigate a sinus in a case where there was only bacteraemia that I am glad to have presented this paper and expressed my views.

I would like to ask Dr. Libmann if the cases showing the long streptococcus in the blood had definite clinical symptoms as well as bacteraemia?

Dr. Libmann:—If these patients all had the clinical symptoms, tenderness, chills, etc.. it would be simple enough. They all had temperature and every case was suspected of having something further the matter.

Dr. Duel:—It seems to me that the bacteraemia may be looked upon as a very strong additional factor in determining early operation, when other signs are present, just as in cases where, finding streptococci in the ear, we would be inclined to operate earlier than where we had found simply staphylococci. I think the whole matter will need a very much longer study, however, before we can say that the presence of bacteraemia without definite clinical symptoms in addition will be sufficient evidence to go further with our operative interference.

The matter of the amount of blood which is drawn for the purpose of making the examination seems to me a most important one and I think a very much larger percentage of streptococci could be demonstrated if we could draw a larger quantity of blood. As our experience with culture methods grows the most important line will probably be in the finding out of the number of colonies to the cc. and we may be able to fix the importance of the presence of the organisms in the blood in that way.

Dr. Libmann, New York, (closing discussion):—I stated that after a mastoid has been operated on and thoroughly cleaned out and the clinical symptoms persist and you find streptococaemia it is wise to go ahead. What could you

expect in the way of clinical symptoms? You may only have the fever. I do not believe the difference between the organisms is so great. The question is what has been done to the mastoid by the time you have seen it. The streptococcus mucosa may cause very few symptoms.

As to the number of bacteria in the blood, we made a study of that in all our cases, but we are limited to a certain amount of blood. If we could get a larger quantity it would of course be better.

NASAL AND NASO-PHARYNGEAL CONDITIONS AS CAUSATIVE FACTORS IN AURAL DISEASE.

By D. BRADEN KYLE, M. D.

In discussing this interesting subject, the natural course of procedure would be first to classify the causes. In the first place, experience teaches us that few aural conditions are primary, so the first natural classification of nasal conditions affecting the ear would be primary and secondary, or one which would be equally good would be direct and indirect. In considering the subject from any standpoint as to classification, it is not my aim to take up any conditions other than those described by the title, as primary lesions of the ear, in no way associated with pharyngeal or nasopharyngeal conditions, certainly do not come under this heading.

Many nasal, nasopharyngeal and pharyngeal causes would be placed under the classifications mentioned above. Yet, different stages of different conditions might change the classification as to cause,—an indirect might become direct, a secondary condition might really be a primary one, as far as the ear is concerned. An equally good classification would be a physiological one, where from physiological causes, nasal conditions causing obstruction to the passage of air might involve the ear secondarily. Another excellent classification would be **mechanical**; for example, where there is inequality in the size of the nostril, or by the direction of the current of air, or by the presence of a foreign body, a mechanical irritation is set up and an ear lesion follows. Where malformations exist, such as narrow nasal orifices, malformations of the nasal bones, irregularity as to the formation of the structures, probably due to some physiological cause such as adenoids, nevertheless such conditions would be classed as an **anatomical** cause. Opposing the

physiological classification would be the **pathological,** where, either by direct or indirect, by primary or secondary causes, physiological lesions develop in the mucous membrane of the upper respiratory tract and secondarily involve the ear. Again, another classification is the **constitutional** cause, where, from some condition of the circulation, some systemic condition involving the secretions, some systemic condition such as an infectious fever, some lesion of the heart, some lesion of the liver, intestinal tract, stomach, or, in fact, of any of the internal viscera, in a secondary way through the circulation and through the irritation of the mucous membrane, may be a primary causal factor in ear lesions. So that the classification of these nasal, nasopharyngeal and pharyngeal causes would depend entirely upon the standpoint from which the practitioner or specialist views these conditions.

Let us enumerate some of the conditions of these structures that will come under the above classifications. The anatomical cause,—the narrow nasal orifice—or let it be an undeveloped orifice due to obstruction in the naso-pharynx so frequently seen in children with adenoids, it may be a malformation, or may be an anatomical malformation not due to the narrow orifice, but due to the fact that there is a malformation involving the accessory cavities, in fact, the entire nasal structure,—such conditions would be important causal factors of aural diseases.

Irregularity in the size of the nostril is equally important. In fact, a wide open nostril or a nostril which admits of a large current of air, is equally as disastrous as a narrow nostril. The direction of the current of air owing to the shape of the anatomical nasal structure may be such that the current points directly toward the Eustachian orifice. In such individuals, ear lesions will certainly result. The mouth-breather,—whether it is due to nasal or nasopharyngeal obstruction, if it is a nasal obstruction, the removal of the same before any damage is done to the ear or the naso-pharyngeal structure, may avert a resulting ear lesion. But

the nasopharyngeal obstruction may be removed, and yet, on account of the bony development, sufficient nasal capacity cannot be established and the individual remains a mouth-breather, setting up a constant irritation of the pharynx, thereby producing an inflamed condition of the naso-pharyngeal structure and involving the Eustachian tube. These conditions come under several of the above classifications. The mucous membrane lining the nasal cavity may be overworked, due to irregularities in the size of the nostril. You may have the hyperplastic condition, causing nasal obstruction. The bone itself may be enlarged. These conditions, of course, would come under not only mechanical, but anatomical, pathological, or even physiological causes.

Traumatism is a mechanical cause, or even a pathological cause.

Atrophic rhinitis, with the shrinking of the mucous membrane, with the wide open nostril, with the formation of pus, with a certain amount of infection,—with the direct or indirect current of air, or the current of air directed toward the Eustachian tube, certainly predispose to ear lesions. The violent blowing of the nose, forcing material into the Eustachian tube, causes primary or secondary, direct or indirect, infectious or noninfectious, mechanical, in fact, could be classed under almost any of the above varieties as to cause. Any form of rhinitis—the simple catarrhal form—would be either a primary or a secondary, a direct or an indirect cause. The postnasal inflammatory condition could be classed in exactly the same way. Take, for example, hay fever or any form of lithemic rhinitis, or the so-called rheumatic or gouty forms, where there is sudden congestion of the nasal mucous membrane, interfering with nasal breathing, and naturally an accumulation of mucus in the naso-pharynx; these would be primary or secondary causes of the ear lesion, direct or indirect, infectious or noninfectious,—simply classified according to the individual case.

Take the specific lesions, tuberculosis, syphilis—in fact, any of the specific granulomata, either from their primary

infection or from a tertiary lesion, where the structure is actually involved,—such conditions may occur either as primary or secondary, direct or indirect, pathological mechanical, in fact, would come under any classifications except physiological.

Under constitutional or systemic causes, take lesions of any of the viscera,—lungs, liver, spleen, kidney, stomach, intestinal tract,—such constitutional conditions as lithemia, rheumatism, gout,—while they are strictly classed under constitutional or systemic, they act as primary or secondary causes, direct or indirect, pathological and even mechanical causal factors.

Age is a factor. Every observing practitioner or specialist knows that at puberty, in both male and female, there is turgescence of the mucous membrane of the nose. There is a mechanical cause and yet it is also a physiological one. There is no pathological condition of the mucous membrane; it is a purely physiological hyperemia, yet from the fact that it interferes with nasal breathing, it may become a primary or secondary, a direct or indirect cause of aural lesion. The same condition would exist at the menopause period. Also in the old, where there is a shrinkage of the mucous membrane, here again you would have a physiological cause, a mechanical cause, a pathological cause, and also a direct or indirect, a primary or secondary.

Children with the sensitive intestinal tract, with their tendency to diseases of childhood, would form another classification as to causes. Intestinal conditions such as constipation, intestinal worms, diarrhoea, the infectious diseases of childhood, would all act as casual factors of nasal congestion, and the nasal congestion then would act as a causal factor of aural lesions. In fact, I think many of our pathological conditions of the ear start in childhood.

One important feature in all these causal factors is this,—that if the cause of the nasal obstruction, no matter under what classification you may place it, is removed, there has been set up in the Eustachian tube or ear any permanent

pathological change, then the removal of the cause will be curative; but if the casual factor remains sufficiently long to produce within the ear area a permanent pathological change, or, in other words, a chronic condition, a change in the tissues, then we certainly will have a permanent ear lesion. This illustrates the primary and secondary condition. Take, for example, tumors of any form—the adenoid tissue involving and blocking the Eustachian tube; nothing wrong originally with the Eustachian tube, nothing wrong with the ear, but through a mechanical obstruction, through a direct or indirect cause, through a primary or secondary lesion, the ear is involved.

Take the infectious diseases of childhood, or infectious diseases of adults. In all these diseases there is an associated inflammatory condition of the mucous membrane and the entire respiratory tract. Besides, there is added to this an infection, each disease, of course, having its own specific infection, but nevertheless exposing the aural cavity to secondary infection. To be sure, this may travel by continuity of tissue, and be a secondary involvement, or it may be a direct involvement owing to the violent blowing of the nose, forcing infectious material into the Eustachian tube. At the same time, there is a lowered physiological condition, a lowered resistance, and a greater tendency to spread of infection. Grippe, typhoid fever, pneumonia, either in children or in the adult, would also be a causal factor. Any infection, direct or indirect, primary or secondary, is an important etiological factor.

Foreign bodies, depending entirely on their size, location and position, would act in a number of ways, mechanical, pathological, primary, secondary,—in fact, in every way but a physiological one.

Occupation is a factor. Individuals confined in close quarters, poor ventilation, dust, various occupations which produce what is known as pneumonoconiosis, dry atmosphere, overheated air, sleeping in rooms poorly ventilated,—all causal factors indirectly to the ear through the irritation

of the nasal mucous membrane and nasal obstruction to breathing, but primarily as far as the ear is concerned. In the case of boiler-makers, ironworkers, and individuals employed in shops where they are subjected to deafening sounds at all times, we have a slightly different condition. There is an internal primary cause on account of the irritation of the mucous membrane, due to the dust and constant change in temperature. Then, an external cause which does not come under the title of this paper, would be the effect on the ear drum when the individual is working in confined spaces and subjected to such deafening noises. Occupation as a cause is well illustrated in engineers, automobile drivers, balloonists, any individual who is exposed to constant draughts and the necessary irritation produced by the rapid passage through the atmosphere.

Under amusements, I have seen children amusing themselves by blowing soap bubbles, forcing secretion into the ear, and setting up an acute ear condition. The violent blowing of the nose can also be classified under every known classification, even the physiological, because it is a physiological process.

Primary lesions of the eye, involving secondarily the nasal mucous membrane, and eventually the nasopharyngeal mucous membrane, may be causal factors of ear lesions. Sinus involvement, in which there is nothing wrong with the nasal cavity, but where infectious material is poured out into the nasal cavity, is also a causal factor.

Another physiological cause, or if I may be allowed to introduce another causal factor as to name, might be the aesthetic cause. This refers to the individual who labors under the impression that each morning he must give his nasal mucous membrane a bath, so he promptly snuffs up quantities of water through the nostril, thereby setting up a resulting inflammatory condition and originating a mechanical, a direct or indirect, a primary or secondary cause of aural lesion.

Sudden changes in temperature, or the temperature cause, is another factor. The sudden change from heat to cold,

or from cold to heat, will produce irritation of the mucous membrane, which irritation may produce some ear lesion.

The cleft palate is also a casual factor. This might be an anatomical one, or a physiological one, or a mechanical one, but we have all seen cleft palates in which the Eustachian orifice was directly exposed and the necessary irritation produced by this exposure to the passage of food, and the irregular passage of air, produced early in life an ear lesion. I have under my care now such an individual who is stone deaf, and his deafness began at the age of five. The mucous membrane around the Eustachian orifice is so thick and fibrous that it is almost impossible to locate the orifice. This, as to cause, might come under almost any variety.

The enlarged and imbedded tonsil, let it be an adherent one or a congenital imbedded tonsil in which, from its location, it obstructs the Eustachian tube or forms a pocket back of the soft palate, keeping up a constant irritation, and becomes an etiological factor in ear disease. The lateral pharyngitis, the simple tonsillitis, in fact, any infection or any primary lesion involving the pharynx or any of the pharyngeal structures, may become a causal factor.

Another causal factor which may be secondary as far as the nasal structures are concerned, is that nervous phenomenon which follows shock, grief, fright,—in fact, any condition which lowers the tone of the nervous system, in which we get the local cyanotic congestion. The engorgement of the nasal mucous membrane would be then a direct and indirect cause of aural lesions. There would also be the direct effect on the ear of the lowered nerve tone. In fact every otologist has seen the case of sudden deafness following shock and grief. While this does not strictly belong under nasal causes, at the same time, the congestion of the nasal mucous membrane is a direct factor.

Hereditary causes might be another classification. So frequently we hear from our patients the statement that they inherited the catarrh, that they inherited the deafness, but if we look into the matter we find that they have inherited

the family nose, the narrow orifice, the high nasal arch, with the long, narrow, slit nasal passage, where the slightest irritation will cause obstruction to the free passage of air, causing early in life a nasopharyngitis, and predisposing the individual to ear lesions.

It is very true, certain inflammatory conditions of the ear exist without any pre-existing nasal lesion, or at least any lesion that is discernible at the time the aural lesion is discovered; nevertheless, in the large per cent. of acute aural diseases such nasal irregularity, either anatomical or pathological, exists.

The above causes bring us to this conclusion, that no matter what classification we may use as to cause, no matter what the obstruction may be, the first point for the practitioner to decide is this, first of all,—Can this nasal causal factor be removed, and if so, has this nasal causal factor already produced permanent pathological lesions in the ear, or will the removal of the nasal obstruction remedy the ear lesion?

NASAL AND NASO-PHARYNGEAL CONDITIONS AS CAUSATIVE FACTORS IN MIDDLE EAR DISEASES.

By G. A. LELAND, M. D., Boston, Mass.

That the nose is the source of all our woes was once stated as the caption of an article in a New York daily paper. That the nose and naso-pharnyx are the source of a great majority of aural woes can hardly be gainsaid. For when we come to inquire into those conditions of the ear which conduce to discomfort, to abolition of the sense of hearing, even to danger to life itself, it will be found that almost all have their morbid origin in this region. For with the exception of certain changes in the secretion of cerumen, which are said to be influenced by naso-pharyngeal circulation, whether exuberant or diminished; also of some markedly virulent cases of external otitis which may possibly pass through a thinned drumhead; and also of trauma, we can exclude largely external conditions as causative factors of middle ear disease.

So also as to invasions from the cerebral side. Trauma, as in fractures of the base, may cause middle ear complications; and aside from this, may be mentioned that still rarer factor, cerebrospinal meningitis which may invade the tympanum through the labyrinth. Thus we are confined in our consideration to the protean forms of middle ear diseases which have their origin in extension of inflammation and of infections from the naso-pharynx. And the reason for this extension must be found in loss of the protection normally provided for the safety and the integrity of the conducting apparatus of the organ of audition.

Now the ear is both the most delicate organ of the body, and the best protected. From without, it is fended from damage by a movable cushion, the auricle, set upon the

hardest bone in the body; the M. T.* its outer limit an inch and a quarter from the surface, approachable in the white races by a narrow curved canal, the inner two-fifths of which is of flinty hardness. From within it is protected by being at the outer end of a tube about 1½ inch in length, whose inner mouth is about 3 inches from the outside. Thus by its position is it guarded from changes of temperature as well as from other sources of injury. Now as most diseases come from the inside, a brief consideration of this protective mechanism may be opportune; and this may be arranged under two heads.

1. Structure of the Eustachian tube, its muscles and surroundings; and their physiological movements.

2. The influence of normal respiration, (Respiratory movements of M. T.)

1. The Eustachian tube is a vertical slit in the side of the naso-pharynx, about 1¼ inches long, and about ¼ inch high, whose sides except at the outer end as it emerges from the tympanum and at the inner opening in the pharynx, are when at rest in light contact. It is lined with columnar cilliated epithelia whose motion is downwards towards the pharynx. The posterior wall of the tube consists of a cartilage which curves over at the top so as to form a hook-like projection forward, below the anterior edge of which the anterior wall consists of a fibrous membrane or fascia which is attached to the anterior tip of the Eustachian cartilage continuous with its perichondrium, and extending downwards becomes part of the tendon of the origin of the tensor palati muscle. This muscle is the dilator of the tube, and would have been called so if it had not been named before Rüdinger described it and its action. (Bezold). It has its origin from the anterior tip of the Eustachian cartilage and from the fascia of the anterior wall and then narrows to pass around the hamular process.

Another muscle is the levator palati, which has its origin from the petrous portion of the temporal bone and "its

*Membrana tympani.

cylindrical belly runs along the floor of the cartilaginous tube, (Bezold) to be inserted into the soft palate.

Hovell describes a third muscle of the tube, the salpingo-pharyngeus or retractor of the tube, which however is not always present. It arises from the pharyngeal end of the cartilage and passes backward and downward into the muscles of the pharynx.

The action of these muscles is obvious. The tensor palati pulls forward the anterior movable fibrous wall of the tube: the levator palati by its contraction swells its rounded belly upward and pushes upward the floor of the tube, and pushes backward the inner tip of the posterior cartilaginous wall. This action widens the pharyngeal mouth, assisted by the action of the tensor, which immediately follows. This pushing backwards of the tip of the cartilage is assisted by the third muscle, though a weak one.

In normal conditions therefore, every act of swallowing, most acts of speaking, and even those of respiration, as they cause movements of the very sensitive and flexible soft palate, also cause this continual opening of the inner mouth of the Eustachian tube.

We can conceive also that when active contraction ceases and the sides of the tube fall together again to a state of rest, the letting downwards of the floor, as the belly of the levator relaxes, acts as pumping or sucking, to draw air and moisture out of the tube, assisted by the elasticity of the drumhead itself.

Now, the inner opening of the Eustachian tube is situated in the midst of the lateral extension of the adenoidal ring of His or Heryng, and in the anterior wall of the tube between the fascia and the mucous lining is a mass of lymph glands. It will be readily seen that when the naso-pharyngeal glands are hyperplastic and hypertrophied and the mucous membranes are swollen because of their presence, the normal movements of the E. T. will be curtailed and the circulation increased to even a pathological degree.

Hence the protection of the middle ear afforded by normal

physiological ventilation and drainage will be lost. Hence will result rarefaction of the air in the middle ear spaces; depression of its only external movable part, the M. T.; the possible consequent effusions, serous or mucous or both, which may cause maceration of the inner walls; and so adhesions, which may take place without inflammation of a sthenic type, without pain or invasion of germs, but producing the insidious variety of adhesive catarrh, which leads to loss of hearing sooner or later, becomes the O. M. C. C. of middle and later life, but which is amenable to treatment at any time, but curable only in the earliest stages.

Moreover, if the tube is covered in and pressed upon by adenoidal masses, or swollen mucous membranes, so that the action of the cillia of the interior is in abeyance and the pumping motion lost, bacterial invasion may pass up the tube, with so-called extension of inflammation, and then may follow inflammatory conditions (O.M.A.; O.M.P.; O.M.P.C.) with all the complications with which we are only too well acquainted.

Both the structure and physiology of these parts point out the rational method of treatment.

2. One of the greatest factors in the protection which should hedge about the organs of hearing may be found in proper normal respiration, and that means **nasal respiration,** first, last and all the time. An English writer said long ago that the Eustachian tube begins at the tip of the nose; that meant that the air passages in front of the Eustachian orifices should be free. Mr. Mayo Collier, of London, has shown in an interesting brochure published some ten years ago, the great influence of nasal respiration upon the integrity of the upper air passages. Others have written on this subject, but as Collier's arguments are especially lucid, they may be mentioned here. There has been much said as to how the accessory cavities of the nose are kept clean, since at least two of these have their only exits near the top of thin bony cavities (antrums of Highmore and sphenoid), and all of them have only very small exits.

Collier shows that this is accomplished by alternate condensation and rarefaction of air, because the nasal orifices are very much smaller than the cavities to which they lead. The air passages including the nose, pharynx, trachea, and lungs, contain a very large quantity of air, and this must be constantly renewed by alternate movements to and fro, through the small nasal orifices. In normal quiet respiration, at rest, 20 cu. in. of air must pass through these orifices 20 times a minute. By exercise or exertion, this may be increased to 30 cu. in. of air, 30 times or more a minute. It is obvious that on inspiration there must occur a partial vacuum behind the introitus nasi, and that on expiration the air pressure must be increased. And it is this alternate variation of pressure which causes an interchange of air through the foramina leading into the accessory nasal sinuses, and keeps the orifices clean. In this category may also be considered the middle ear cavity, for its ventilating tube is only somewhat longer than that of the frontal sinus.

That these respiratory movements actually take place was shown by Politzer in 1860 by the use of his manometer and has been shown by another European observer who was able to see these movements by covering the M. T. with an irridescent paint and using a magnifying glass for accurate observation.

The writer also had an experience which amply proved to his mind that these respiratory movements take place. Some years ago a laborer was admitted to the City Hospital with large exostoses of the external auditory canal. On account of pain and deafness caused by accumulation of epithelial debris which could not be removed through the occluded canal, the exostoses were chiselled away after the removal of the cartilaginous and cutaneous canal. There was a perforation through the M. T. and the wound became infected. One morning on removal of the packing, a bubble was formed over the canal orifice, which swelled out with expiration and was retracted with inspiration, which move-

ments were constant till the bubble burst. His Eustachian tubes were apparently not abnormally open; but this observation and the experiments of others clearly show that there is a movement of air through the E. T. even though its walls are in apparent contact, and even though the force of the respiratory currents may not be very great.

From the foregoing may be deduced the rationale of treatment. Continuous nasal respiration is essential to the preservation of proper passages through the nose; that is, by the proper circulation of air through this region, proper circulation of the blood and lymph fluid is maintained.

Upon this also depends the normal condition of the naso-pharyngeal surfaces, and it is undoubted that the increase in the size of the lymphatic chain which surrounds the upper entrance to the body is largely caused by the lack of the proper play of air through the nose. Slight colds and carelessness of the medical attendants as well as of the parents allow the mouth to be used instead of the nose for respiration. Hence the space not being needed is filled up by hyperplastic lymph masses, called adenoids. The proper movements of the Eustachian tubes are thus curtailed, and thus in earliest life is the foundation laid for deafness after the soft stage of life has passed, that is, after middle life. The time to cure therefore O.M.C.C. is **before** the initial earache has taken place or exudate has formed, which causes depression and probably subsequent adhesions in the middle ear; and though in a very limited field there is no part of preventive medicine that can have more far-reaching individual importance than the prevention of these initial earaches in the very young.

To this end almost universal education must be promulgated to teach people that their children must not be allowed to have earaches and the general indifference of the community to even a slight earache must be removed, for the middle ear never forgets it. Too many of us, and the writer speaks from personal experience, are suffering from this very neglect which took place in our earliest life; and

it is a very serious question for the individual when he gets along in life to a position of some importance, at least to himself, if he finds that he is to be shut off from the activities and pleasures of life more or less, by the inevitable encroachment of almost irremediable deafness which could have been prevented had it been taken in time.

Hence the earliest symptoms of the presence of these growths must be a warning to us for their removal. Slight colds which are frequent and last a considerable time should call attention to the ears and if the drumheads are found to be dull and lustreless, the air in the middle ear having been diminished or lost, the naso-pharynx and especially the fossa of Rosenmüller should be immediately cleaned out and nasal respiration insisted upon. But supposing the earaches have already taken place, delays are dangerous at this stage, not only for the present but more so for the future; and from what has been said it seems deducible that the rational method of treatment even then is to clear out the naso-pharynx and fossa: that is, to hasten the mechanism of opening and shutting and pumping the E.T. To this end the sides of the naso-pharynx should be relieved of the growth which is inevitably present, for I am sure there is no child to be seen with earaches not caused by an injury, where adenoids are not present; with the possible exception of the infections of the exanthemata and of influenza; and even here it is doubtful.

To possibly throw some light on this point, my assistant, Dr. Henry Tolman, Jr., examined last week 127 cases in the scarlet fever wards at the Contagious Department of the Boston City Hospital. It is well known that this disease often, if not always, causes an increase in size of these naso-pharyngeal lymph tissues. I was surprised to find that he found 43 cases without adenoids. There were 84 cases with adenoids and of these it is again surprising that there were 72 without aural complications either past or present. Of the 12 cases with aural complications, acute or chronic, all had adenoids and of these only 5 had them generally dis-

tributed and the other 7 had them only in the fossae of Rosenmüller. This bears out my reiterated statement that children with earaches always have adenoid growths, and further emphasizes the importance of clear fossae of Rosenmüller.

It has been the writer's privilege in numerous cases on the on-coming of earaches to scrape out the fossae of Rosenmüller and the sides of the naso-pharynx at the mouth of the E. tube, and to have others do it under his direction in the hospital In almost every instance, (I recall no exceptions), drainage has been established, inflammation of the ear has gone down, and perforation, pathological or artificial, was not necessary. Of course this procedure which looks barbarous cannot be done in every instance. Unfortunately we have to defer to the opinions, whims, and prejudices of guardians and parents; but in those instances where I have been given permission to do it or where the more formidable ether operation has been allowed, the immediate removal of these growths from the naso-pharynx has been followed by an immediate subsidence of inflammation in the middle ear, both in children and adults.

Hence with this etiology in view, the rhinologist evidently is the most natural aurist for the beginning of these cases. Now if these cases have been allowed to run on and the insidious variety of adhesive catarrh has commenced to take place, with or without adhesions, the most rational treatment is that aimed to establish the proper physiological movements of the pharyngeal mouth of the Eustachian tube. From what has been said it will be recalled that the mouth of this tube is never at rest; that its continuous movements tend to renew the air in the middle ear; but that if the side of the pharynx is swollen and especially if there is present a mass of adenoidal tissue, the older the tougher, or of adhesive bands or cicatricial tissue **in the fossae of Rosenmüller,** the pushing back of the tip of the tube by the levator palati, and the pulling back by the retractor of the tube cannot take place. Hence the proper movements are cur-

tailed. Formerly the customary treatment in these cases was by inflation of the middle ear by the Politzer method, or by the use of the catheter; also by means of tragus massage after Hommel's method, aiming thus to keep up the mobility of the drumhead. In most of these cases lasting improvement did not take place, and could hardly be expected when these grosser methods of inflation were applied only once or twice a week; and it is a question whether the use of Politzer's bag is not injurious because it is usually used with so much force and because these forceful methods produce an overstretching of the M. T. and middle ear structures.

The proper method therefore in the writer's opinion is to establish the physiological movements of the air, and to this end must be restored the integrity of the region of the mouth of the Eustachian tube. The fossae of Rosenmüller must be kept clean and wide, so as to permit the proper excursions of the posterior lip of the tube. Therefore it may be said that the operation for the removal of adenoidal vegetations in whatever time of life it is performed, is far from complete and in fact utterly useless where adenoids are removed only for the restoration of the respiratory space, and not for the restoration of proper movements at the sides of the nasopharynx; i. e. utterly useless as far as the ear is concerned.

Moreover one result of the operation in this fossa which is a sulcus narrowing at depth outwards, and which by the rhinoscope may appear but ¼ in. deep, but which by the use of the finger may be found to be ½ in. or more in depth, is to wound its surfaces. Hence as these surfaces are movable, there is a tendency for the production of adhesions so that sooner or later after the operation this fossa will be found to be occluded by fibrous tissue or by a re-production of adenoids which it is a fact are absolutely impossible of complete removal, especially in this locality. Hence in order to keep these fossae clean so to insure their proper movements it is occasionally necessary to scrape them after the major operation and to make application of astringents

in them soon and perhaps frequently afterwards to keep the adhesions from forming.

Now it is evident that such subsequent treatment is difficult of accomplishment; but it is also evident that in many cases it will be necessary if the proper movements of this tube are to be established and hearing preserved: that it is wthout doubt much better to suffer a few weeks of uncomfortable treatment, than that the rest of life after middle age or earlier, should be compromised by increasing deafness.

But the obliteration of this fossa more or less complete is not confined to early life. It frequently obtains also in adults with increasing deafness, and compromises the proper movements that establish ventilation of the middle ear. It seems to the writer much more rational to re-establish proper movements of these parts whereby the patient treats himself by the motions of swallowing, and by movements of respiration 20 to 30 times a minute, than it is to rely wholly on the use of the catheter or Politzer's bag. I beg to submit that this auto-treatment is much more effective where the middle ear has not been too firmly bound down by adhesions, than any other treatment which can be artificially applied. To emphasize this position might be cited numerous cases which have been formerly under treatment for many years, where the re-establishment of these palatal and respiratory movements has brought the ear back to a satisfactory degree of hearing and given the patient much greater comfort and a brighter outlook on life.

In one case a man of 60 years of age, where a diagnosis had been made of anchylosis of the stapes and the patient after 25 years of treatment had been given over to that hopeless state where further treatment was considered useless, the establishing of these movements brought back hearing so that it was considered by his family that he had been restored to his normal condition.

Another case of 58 years of age, after the same length of former treatment, had been given over to occasional ob-

servation without treatment which was considered hopeless interference.

The hearing has been restored from 1 inch right ear and ½ inch left to between 1 and 3 feet right ear, and ½ to 1 foot left, for Politzer's acoumeter. Here general conversation at the table had been wholly lost, but now there is comfort at the table and in the office which had been unknown for years.

Another one, a man of 64 years of age, after 40 years of ordinary methods of treatment, finally consented to have his nose restored, the swellings of his naso-pharynx reduced, and so was brought into a condition where intercourse with his fellow men has now become a comfort when formerly it was a trial.

The reason which may be given for this difference in these cases is deduced from what has been said above and here reiterated, that the proper respiratory and naso-pharyngeal movements are operative 24 hours in each day, 20 or more times a minute, and that these very gentle movements of the drumheads tend to stretch or make flexible the stiffened membrane and even the adhesions; just as continual dropping of water may wear away the rock. In the writer's opinion this rational method of treatment has given better results in cases of encroaching deafness than are produced in any other way; and that in many cases this treatment must be insisted on at the very beginning of life.

There is one form of disease in which as yet very little progress has been made: viz., oto-sclerosis. May it not be true that even this disease started by inflammatory attacks in early life, influenced by rheumatism and other dyscrasiae, may be prevented with all the rest by rational treatment of the naso-pharynx, **before these inflammatory attacks are begun?**

Dependent on the nose and throat may be mentioned several isolated symptoms. And the first is pain. Many patients come to us complaining of earaches where after careful examination there is no evidence of inflammatory

mischief in the middle ear or its annexes. This pain is therefore reflex and may come from various locations, even from the aryepiglottic folds or from the sides of the larynx, as was shown many years ago by our colleague, Dr. J. Orne Green. Most frequently it comes from the tonsils, radiating upward. It occasionally comes from swelling of the lateral pharyngeal lymphatic bands behind the posterior pillars of the fauces, which pass up around the region of the Eustachian tubes. It may come from a tooth painful because of decay or improper striking, for any part of the tri-geminal in its myriad branches may have the cause of pain which may be referred to any other part. Also we may have pain in the ear from intra-nasal pressure, from suppuration of the sphenoid, and probably also the ethmoid; but this only shows that in some cases the whole periphery or whole nervous supply must be overhauled to find the cause.

The second symptom of this nature is a feeling of fullness in the ear, as if there were a plug of cotton, the removal of which would clear up this condition of discomfort. I have found this pressure feeling to be only a lesser degree of that which means pain, and to be caused in a large number of cases by pressure of the corresponding second turbinal upon the top of the third, or on the outer wall. The removal of this pressure clears up the feeling of plugging and it is utterly irrational to inflate the ear in these cases, for in most of them hearing tests will prove that the ear being all right, there can be no cause for the sensation there.

The third symptom to which I would like to call attention is tinnitus: and especially the low-toned roar, often with pulsations, or as the patient describes it, a hammering. In these cases there is frequently an effusion in the middle ear, but as often the tympanum is clear. That this variety is often due to hyperæmia of the lymphatic structures in the sides of the naso-pharynx, and especially in the fossae of Rosenmüller has been abundantly proved by its almost immediate cessation after they have been cleared out and kept clean by astringent applications, often necessarily made with

considerable force. So also the hissing variety of tinnitus, especially in late or even middle life, is often though less surely diminished or abolished by reduction of the circulation around and inside of the mouth of the Eustachian tube. And to this end, for a result more or less permanent, let it again be reiterated that normal, unobstructed nasal respiration must be established; and further that that most common of all nasal obstructions corrected; viz., the vicious habit of mouth breathing.

The fourth and last symptom is vertigo. The occlusion of the nose with its hypercirculation is occasionally responsible for this symptom even without active aural lesions. An old habitué of the aural service many years ago is well remembered, who for several months came to the clinic led by his daughter because of staggering in the street. He was treated aurally by me three to four months with little relief, by my colleague for the next six months, and was still coming in the same way when the service was changed. Then it was discovered that his turbinates, lower and middle, were much engorged. On reduction of these bodies the vertigo ceased and hearing improved. This case has served good stead as a pointer to occasional cases of nasal vertigo.

In speaking of these functional movements, those produced by blowing the nose have not been mentioned because it is considered together with the Valsalvan experiment a pernicious practice, resulting too often in over stretching of the membrana tympani and of the middle ear tendons and ligaments; and because proper treatment and proper use of the nose should make the use of the handkerchief unnecessary; for there is no doubt that this act increases congestion and intensifies most morbid conditions.

In closing it must be conceded that the whole subject has by no means been touched upon in this paper—it is too large for the time allotted—that many of the diseases of the ear, of inflammatory and infectious extensions, have been only hinted at; but it has been attempted to call attention to certain principles which have been of value as stimuli in prac-

tice, and to certain methods which have been followed by satisfactory results. Nor is it thought for a moment that anything new has been brought forward, anything outside of the practice or experience of most, if not all, of this audience of specialists; but only that this paper is a small part of this symposium which with its discussion is to go out to do missionary work among the family physicians, and especially the pediatrists, and even the obstetricians, who have to do with the youngest victims of these troubles, when treatment is most effective for the future as well as for the present; and also to make clear that treatment of the naso-pharynx, especially operative treatment, is in the province of the aural specialist, since its effect on the function of hearing is of the utmost importance.

NASAL AND NASO-PHARYNGEAL CONDITIONS AS CAUSATIVE FACTORS IN AURAL DISEASES.

By NORVAL H. PIERCE, M. D., Chicago.

Aural disease may be caused by pathological conditions in the nose and pharynx, including the epipharynx, in three ways: First, mechanically, by pressure on the tube or by interference with its ventilating mechanism. Second, indirectly (a) by hyperemia and stasis (collateral edema) which, by extension, reaches the middle ear from the nose and pharynx; (b) by toxins formed elsewhere which are transported to the ear without the presence of microorganisms; (c) reflexly, by way of the nervous mechanism, as in the otalgias accompanying tonsillar calculus, elongated styloid process, granular pharyngitis, etc. Third, directly, by the transportation of inflammatory incitants from foci established in the nose and throat.

The consideration of the subject may be approached from a pathological, anatomical or clinical viewpoint. From all standpoints, the greatest importance attaches to hyperplasia of the lymphoid structures constituting the upper portions of Waldeyer's ring. The nature, anatomical relations and symptomatology of these structures cannot be exhaustively studied in this paper for obvious reasons. It is sufficient for the present purpose to say that besides the large mass of lymphoid tissue situated on the posterior and upper wall of the epitympanic space known as adenoids, there are smaller groups of the same tissue situated in Rosemuller's groove, in the nasal chambers, especially along the floor, scattered over the soft palate and, most important, within the Eustachian tube itself. Not always is it the volume of adenoids alone that interfere with tubal ventilation, either by stopping up the tube or by pressure interfering with the ventilating ap-

paratus, but this is in large part due to the quantities of tenacious mucus which is extruded by these growths as a result probably of inflammatory action. The same may be said of these growths as they interfere with respiration. It is a well known fact that the greatest annoyance in this regard occurs at night. During the daytime respiration may be much more normal, because gravity assists in draining the mucus into the mouth and esophagus. At night, however, this is no more operative, on account of the recumbent position; the tenacious mucus accumulates in the choanae and post-nasal spaces, and the individual is forced to breathe through the mouth. As deep sleep approaches, the tongue sinks back in the mouth and is eventually aspirated against the soft palate. Respiration becomes impossible and the victim, awakened by suffocation, adjusts the tongue, sinks again to sleep, only to experience a repetition of the torment. No wonder these little sufferers are disturbed by fearful dreams, frequently accompanied by enuresis.

On account of the nasal stoppage, food is hastily taken and insufficiently masticated, for the mouth must be used for breath. Because of some subconscious impulse, perhaps, the very desire for food is lessened.

The poor suckling fares especially hard. He cannot nurse and breathe at the same time, and his puny protests at this unfair fate, as well as the cachectic condition into which he falls, if not relieved, have been witnessed by us all. Children with adenoids and enlarged tonsils are under nourished; they arise from their troubled sleep unrefreshed; they arrive at school already weary; add to this defective hearing and the superimposed nervous strain by which they endeavor to overcome the defect, and we have an explanation of their mental backwardness that is at least as satisfactory as Guye's elaborate hypothesis of aprosexia nasalis. You may regard this as an unwarranted digression, but I have thought it wise in order to emphasize the fact that these children are most liable, not only to aural, but to all other infections.

Whether because of mucus in the Eustachian tube or because of the mechanical stoppage of the tube by the mass of adenoids in the epipharynx, or within the tube itself, or because of pressure in the cushion interfering with the ventilating apparatus, certain well-defined conditions result within the cavum. The tympanic membrane is displaced inwards, and with it the ossicular chain. In consequence, the equilibrium of the conducting apparatus, which normally is capable of movements at the foot-plate of the stapes far beyond our present power of miscroscopic measurement, is disturbed, and a loss of audition results. The cause of this displacement is generally ascribed to a loss of atmospheric pressure in the cavum, the plus atmospheric pressure in the external auditory canal being exerted against the tympanic membrane, pressing it inward. To the writer's mind, however, this is not a closed question.

Bezold regards the cavum as a modified pulmonary vesicle, which, while changed to the extent of containing a portion of the auditory apparatus, retains its ancient power of absorbing oxygen and throwing of carbon dioxide. This can hardly account for the great retraction of the tympanic membrane we find in some cases. The capillaries are incapable of absorbing so much oxygen. In the lung four-fifths per volume remains after respiration. To account for a greater rarification, Koerner likens the process which occurs in the cavum to that which takes place in the resorption of a pneumothorax by the pleura, and ascribes to the lymph spaces in the epithelial cells of the mucosa the greater part of the absorption of the gases. When we recall how completely a pneumothorax may be absorbed and the pleural vacuum reestablished, the latter hypothesis seems more reasonable. Whether or not contraction of the tensor tympani contributes to the retraction of the tympanic membrane in recent cases is, in the writer's opinion, an unsettled question. Surely, there are cases of short duration, in which even by forcible inflation with the catheter, the membrane does not resume its normal contour or position.

The writer has advanced the theory that the plus carbon dioxide, if we accept Bezold's theory, would tend to cause contraction of the muscle. Against this has been brought the fact that the tensor is isolated from the cavum in its canal, only the tendon projecting into the cavity of the drum, and that further it has its own blood supply. Still it may be urged, if the plus carbonic acid gas is absorbed by the lymph spaces of the epithelium covering the tendon and about that portion of the muscle nearest the cavum, a sufficient plus quantity may be conveyed to the muscle itself to cause contraction.

Your Secretary, when he invited me to take part in this symposium, expressed the hope that I would be practical in my method of treating the subject. I fear, as he sits there listening, he must experience a sense of disappointment. But at the expense of adding to this disappointment I feel constrained to dwell upon another subject that must be regarded as unsettled. We must accept the clinical fact that the sinking-in of a drumhead is caused by insufficient ventilation due to tubal obstruction, but it is a question whether the exudates that frequently accompany the same condition can be regarded as of purely mechanical origin. The condition as it occurs in the brain—hydrops ex vacuo meningeus—cannot be used as a comparison, as there the brain mass shrinks in a cavity with unyielding walls. It may better be compared to the exudative process as it occurs in meningitis serosa or in pleural exudates. Years ago the writer proved that the serous aural exudates, especially as they occur in young children, with tubal stoppage, were not only sterile, but were occasionally possessed of a certain bactericidal power (Jour. American Med. Assoc., December 9, 1906). Notwithstanding this, it is more in accord with general pathology to assume that serous exudates result from inflammatory agencies, if not directly at least indirectly; if not from direct bacterial invasion of the tissues involved, at least indirectly from the action of bacterial toxins elaborated elsewhere, as in the case of the two in-

stances quoted for comparison. This has been proven in reference to some aural manifestations as they occur in connection with the pharyngeal invasion of the bacillus diphtheriae.

If this view of the subject is accepted, then the term hydrops ex vacuo meningeus is no longer tenable, and should be dropped from our nomenclature.

Tubal obstruction as it occurs from hyperplasia and bacterial invasion of the adenoid tissue in the pharynx and epipharynx forms the keystone of a great part of aural pathology. If early operative assistance is extended to these cases, the results are most brilliant and lasting, yet not a few require after-treatment by means of inflation, massage, local applications, etc. The neglected cases form no inconsiderable number of those instances of defective hearing in adult life, where the changes in the aural apparatus are permanent. Among these may be mentioned: malposition and malformation of the conducting apparatus, adhesions, atrophy of the membrana tympani, luxation of the long process of the ambos from the head of the stapes, stapes anchylosis, spontaneous rupture of the membrane with consecutive cholesteatoma formation. In not a few cases of chronic aural suppurations has the removal of hyperplastic tonsils and adenoids been followed by a cessation of the discharge.

Here I wish to state the belief that nasal obstructions **per se** do not cause aural disease, as witness those cases of congenital atresia of the choanae in which the auditory apparatus remained normal for years, or the cases of postnasal fibroma, in which the ear is unaffected until pressure necrosis causes a breach in the surface continuity of the tumor, and hemorrhage, accompanied by inflammatory phenomena, or cases of nasal polypi in which the ears are unaffected, occurs.

I am reminded further of one of my guides in a recent hunting expedition in New Brunswick, whose hearing, in spite of a pronounced septal deviation, was much more

acute than mine, although he was nearly twenty years my senior.

There must always be, in addition to the purely mechanical obstruction, inflammatory factors present to produce disease of the middle ear that is of nasal origin. In saying this I do not wish to be understood as underestimating the importance of nasal obstruction as an indirect and important factor in the production of aural disease. Every constriction within the nose, whether it be bilateral or unilateral, may cause hyperemia and disturbance of nutrition in the tissue back of the constriction, by reason of the rarification of air which occurs there. Such constriction is caused by collapse of the alae of the nose, due to paresis of the levators, which occurs in mouth-breathers. Deflection of the septum acts in the same way, as do hypertrophies and turgesences of the turbinated bodies, especially when accompanied by excesses in eating and drinking. These individuals are constantly "taking cold." The chronic hyperemia and the disturbances of nutrition behind these constrictions render the tissue less resistant to bacterial invasion so that each acute exacereation is liable to be followed by invasion per continuity of surface of the tube and cavum, as well as the accessory sinuses.

These sinuses are not infrequently unsuspected depots for the distribution of infectious material in aural disease. Everywhere, however, we see bacterial life playing the paramount role, due, it may be in many cases, to the lowered resistance of the nasal mucosa, caused by nasal obstruction. But this leads me to say that not infrequently the same conditions may be brought about in the nasal mucosa which lead to affections of the ear by errors in living, excesses in drink, lack of fresh air and exercise, overwork, worry, and the thousand unnatural shocks that our artificial life is heir to. And, further, clinical experience teaches that if the inflammatory factors are not superadded to nasal obstruction, these may be most extensive and pronounced without the occurrence of aural disease.

In conclusion, I shall take this opportunity to raise a protesting voice against the widespread and irrational removal of slight irregularities of the septum and turgescent turbinated bodies in the mistaken belief that such slight irregularities play a considerable part in the production of aural disease. The idea of nasal insufficiency has been carried to unwarranted extremes by many operators, and no little unnecessary suffering has been caused by their misguided enthusiasm. In not a few instances which have come to my observation have these operations been performed on patients whose conducting apparatus had been long before permanently injured by previous pathological processes, the results of which are atrophy of the tympanic membrane, malformation of the malleus, dislocation, adhesions, etc. I have been especially impressed by the unnecessary nasal and pharyngeal operations undertaken with the vain hope of relieving cases of uncomplicated otosclerosis—a disease that has no etiological relationship with nasal obstructions. Let us remember that the anemic, overworked clerk may need fresh air, nutritious food and fair fields more than our turbinate scissors—the irritable neurasthenic other treatment than our nasal saws.

I wish to thank you for so patiently bearing with me in taking up so much of your time in discussing so well worn a subject.

Discussion.

Dr. E. A. Crockett, Boston:—I wish to particularly emphasize one point brought out by Dr. Pierce, that is, the fact that the nose is often operated upon without any regard to the pathological conditions which appear, and the prognosis given the patient in such cases is often entirely erroneous and unjustifiable. For instance, it seems to me to promise a patient who has a high grade of otosclerosis that any form of pharyngeal operation will improve his hearing to the slightest degree is unjustifiable. It seems to me that is a

matter which is perhaps too simple to need emphasis, and yet it has been my experience many times in seeing cases in consultation, or in the hands of other practitioners, that it is a frequent error. Otosclerosis is not a disease which originates in the nasal pharynx and is characterized by a high grade of deafness which is not going to be influenced in its course by any form of intranasal operation. It also seems to me that the operations upon the nasal septum and upon the anterior portions of the nasal turbinates and also upon the accessory sinuses are not going to influence the patient's hearing at all. It is a matter of frequent experience with a specialist to see patients with deafness with no septal deviation at all, and those with septal deviation with no deafness, and I have yet to see a case where operation upon the nasal septum has resulted in alteration of the hearing to any extent. If the nasal or pharyngeal conditions which exist do not influence the moving of the Eustachian tube no improvement is to be expected from intranasal surgery. That brings me to a point particularly well covered in this symposium,—the presence of the tissue in the fossa of Rosenmüller or in the upper portion of the nasopharynx where peri-adenitis and pharyngitis are of extremely common occurrence. This is the first meeting that I have had the pleasure of attending where this subject has been so thoroughly brought out. It is very common in this portion of the country to find patients on whom adenoid operations have been performed where the lateral portion of the pharynx has not been touched at all. That is not done by good operators, but often occurs, and if you see a patient of that sort after an adenoid operation has been performed, with no benefit to the hearing, do not dismiss the patient without digital examination of the pharynx. There are cases of very large growth where you can see everything with the mirror, but this is not common. You should get your finger in, with or without an anaesthetic, and carefully feel the vault, the upper portion of the post-nasal space, and the fossa of Rosenmüller on either side,

and you will find adhesions, remains of adenoids, or periadenitis of very common occurrence, and by removing these remnants you may get a very distinct improvement in your patient. When it comes to the nose itself it is a matter of considerable infrequency to get improvement in hearing or cessation of a progressive deafness from intranasal surgery.

Dr. Otto T. Freer, Chicago:—I wish to say a word in regard to the recessus pharyngeus medius, referred to by Dr. Logan, and the bursa pharyngea, often confounded with it, but regarded as not identical with the recessus by anatomists. The bursa is supposed to be a foetal structure and is a pocket which extends into the periosteal covering of the occipital bone. The recessus pharyngeus is merely a survival, after atrophy of the pharyngeal tonsil, of the deep, saggital cleft in its center, which persists as a recess or pouch into adult life. Such pouches I have seen in the past but I have never encountered a true pharyngeal bursa.

In two of my patients hemorrhagic discharge from the nasopharynx was the characteristic phenomenon of a persistent recessus pharyngeus medius. In each instance the index finger entered a cavity with an orifice which grasped it and the contact of the finger provoked bleeding. Complete recovery took place in both cases, after removal of the adenoid tissue which formed the wall of the pouch with my pernasal adenoid forceps, showed in the American Laryngological Association three years ago. With this forceps it is also possible to thoroughly clear out the fossa of Rosenmüller without injury to the tuba auditiva and in fact to absolutely extirpate adenoid remains in any part of the nasopharynx.

A third patient had symptoms to which Dr. Logan has referred; the formation of scabs in the vault of the pharynx. The persistent reproduction of these caused a German specialist to mistake the suppurating recessus pharyngeus medius for empyema of the sphenoidal sinus so that he opened this cavity not only without benefit to the patient,

but with serious consequences to his health in the form of sepsis and suppuration of the cervical glands. Complete relief was obtained as the result of continuous washing away of the scabs with my nasal irrigator.

Dr. W. L. Ballenger, Chicago:—I want to emphasize some facts which have been brought out by the various papers, and perhaps more particularly those brought out by Dr. Pierce. Dr. Pierce made it plain to us that simple obstructions in the nose are not the cause of middle ear disease very often, but that there must be an associated inflammatory condition, which I think is the correct view. In the past years one reason we failed to get results following middle ear disease was because we operated upon the wrong portion of the nose. The obstruction lies high in the nose. Deviations of the septum do produce infective conditions within the nose, and these extend upwards in the epipharynx and into the middle ear and produce deafness. If we direct our attention to these conditions in the nose we would then find that if operated at an early enough period the ear conditions would very often be relieved, and I have found that there are a few conditions that generally have to do with the causation of middle ear deafness and inflammation. These conditions are first, ethmoiditis and sphenoiditis, and second, enlargement of the posterior ends of the middle turbinate, and associated with this we often find epipharyngitis; the third condition, which is a very fruitful source of deafness, is the presence of adenoids, which are almost universally associated with periadenitis. So that I have been in the habit of teaching my students these three facts as being the main persistent causes of middle ear disease. The other causes enumerated are very frequent, but these three are very common at present and are very fruitful of middle ear inflammation and deafness, and I have had numerous opportunities of watching the beneficial results in giving the proper attention to these three conditions. I had one case of chronic mastoiditis in which I did a radical operation

in which there was a persistent discharge from the Eustachian tube. This young man had adenoids and I removed them and the discharge from the Eustachian tube promptly ceased. There was another feature I wish to enlarge upon, namely, that middle ear suppurations are apparently almost always associated with one of these three conditions. Of course, there are some cases that come from acute infectious diseases without these conditions, but in the large percentage of cases we have one of these three conditions present, and we all know that in children we find that this suppurative condition will disappear after the removal of adenoids, and if we would carry that same thought to adults we would be surprised to see how many of them would be improved by the removal of these growths, because these adults that have these chronic ear discharges have remnants of adenoids. Another point is that adenoids do not necessarily atrophy at the age of puberty. As a matter of fact, the mouth breathing ceases at this time, but the adenoids are just as large in adults as in children.

Dr. G. L. Richards, Fall River:—This is a very important subject; we have been trying for years to get something to help us in the line of treatment of these cases of otitis media, and since in the last two or three years we have come to the study of the relation of the fossa of Rosenmüller we are getting some help. I want to speak of two or three points, first, in reference to the examination you make of the patient in the office. Mention has been made of sterilizing the finger. If you have a box of very thin rubber finger cots in your office, which can be made perfectly sterile, you can examine a patient with all the facility of the bare finger and with more facility in introduction. That is a simple point which makes the examination in the office quite a little easier. In the operation for adenoids most of the forceps or the curettes do not follow in a great many cases the anatomy beyond the fossa of Rosenmüller because they are not long enough and are too wide. Vogal has devised an adenoid curette which is admirably adapted to follow the

fossa of Rosenmüller. After you are through with the other part of the operation and you want to be certain you have left nothing behind this can readily be proved by the use of this curette. At the result of the removal of these remnants one is sometimes agreeably surprised. The other day I removed the tonsils from an adult under anaesthesia, who had poor hearing in the right ear. As I was taking her from the table back to the ward it occurred to me that as she was still under the anaesthetic, I would feel up in her naso-pharynx and see what might be there. There was quite a band of adhesions and I separated these with my finger, and much to my delight two weeks later the girl said she could hear much better. One other point, Dr. Packard referred to the work of Dr. Tervey of South Carolina, I wish to say that we have in the audience today, Dr. F. P. Emerson, whose work in this direction goes back quite as far.

Dr. Emil Mayer, New York:—I merely wish to call attention to an addition to our armamentarium in examining the pharynx presented here by Dr. Coakley, and which I am sure he would have mentioned in his paper had he been able to read it. The instrument is that known as the pharyngoscope which is on the plan of a cystoscope, and enables us to make examinations and find these conditions even more readily than with the finger.

Dr. Percy Fridenberg, New York:—In regard to the routine examination of the nasopharynx, which a number of the gentlemen have referred to, it seems to me we have in the Hays pharyngoscope a very valuable addition to our armamentarium. The finger is undoubtedly a good probe, but you cannot keep it in the post nares very long, and in many cases prolonged examination is necessary. With the laryngoscope in position, you can study the very smallest growth in the post pharyngeal space with no discomfort to the patient. I have tested the instrument for ten minutes while making a careful drawing of the post nares. Another

great advantage of this instrument is the fact that you can study the various changes which take place in deglutition or coughing or gagging and see just what does happen to the muscles of the soft palate and the muscular structures about the orifice of the tube. One of the gentlemen has called attention to the involvement of the muscular structures in the production of sclerotic disease of the middle ear. I confess my inability to understand the very beautiful drawings which were handed about. I do not see how we can detect interference with the muscles by examination from the outside. If you examine the post nares with the pharyngoscope during swallowing you see, even in very marked cases of adenoid growth, practically normal contraction of the soft palate and muscles around the tube. As far as obstruction is concerned, you see pressure from the outside in a few cases and none where there are adenoids in the fossa of Rosenmüller. I have examined in the last two months a large number of cases of adenoids in both children and adults, and in few cases was there compression during swallowing, but almost invariably solid masses of mucus were pushed between the soft palate into the Eustachian orifice and into the cavity of the pharynx. I want to allude again to the pharyngoscope, which I demonstrated yesterday. I then mentioned that the great advantage of the instrument would be that it enables us to control with the eye the introduction of a catheter into the Eustachian tube, and not only for our own purposes of performing that operation but for the purpose of teaching, it will be a very valuable adjunct.

Dr. Emil Gruening, New York:—I merely wish to record that the name of the inventor of the pharyngoscope is Dr. Harold Hays of New York. I have heard no mention of this fact in the remarks upon the instrument.

Dr. Geo. E. Shambaugh, Chicago:—We can all agree that middle ear trouble frequently has its origin in conditions found in the nose or throat. This is of course especially

true of tubal catarrh in cases of adenoids. While this is true we must be cautious how we express ourselves regarding the relief of many middle ear cases associated with abnormal or atypical conditions in the nose or throat. The emphasis placed on the causative relation existing between the nose and throat and the middle ear disease has resulted in a great deal of unnecessary operating, especially in the nose in the correction of slight anatomical variation such as spurs on the nasal septum. We have all of us seen cases of suppurative middle ear trouble get well after removal of the post nasal adenoids. We all of us know, too, that when a case consults us on account of defective hearing, the result of scar formation in the tympanum left over from a previous middle ear suppuration, that we cannot hope to improve the hearing by operating on conditions in the nose or throat. Now in cases of catarrhal otitis media the situation is exactly the same. The time to expect improvement in the hearing by removal of obstructions in the nose or throat is especially during the exudative stage. When these cases consult us years later, with the middle ear dry and the tubes often wide open, it is hardly to be expected that any improvement in the ear trouble can be affected by operations on this or that condition in the nose or pharynx.

One more point: We must not fail to make a sharp distinction between cases of middle ear trouble and cases of bony fixation of the stapes due to otosclerosis. Again there are many cases of middle ear trouble associated with labyrinthine diseases where the latter condition is the main cause of the defect in hearing. Such cases cannot be benefitted by operation in the nose or throat. We should not lose sight of the fact that in every case where the deafness is at all severe there is present a more or less extensive involvement of the labyrinth, since no degree of obstruction in the conducting mechanism can in itself produce the severer forms of deafness.

Dr. Kyle spoke about the different forms of occupation deafness in a way that might give the impression that oc-

cupation deafness could be of a middle ear type. By occupation deafness we usually mean labyrinthine deafness.

Dr. W. K. Simpson, New York:—I wish to ask Dr. Logan if he has had any experience in producing an atrophic condition of the nasopharynx in removal of the thickening in adolesence and in adults? I have seen a number of instances where a certain amount of so-called hypertrophied tissue in the nasopharynx has been removed and a very marked condition of atrophy has been produced.

Dr. J. F. Barnhill, Indianapolis:—Concerning the adhesions of the Eustachian tube I wish to say a word, and to receive some explanation from those who have brought the subject forward. I have read the several articles that have appeared and have tried to act on them. The result in most instances has been disappointing for the reasons that have been advanced by Dr. Shambaugh, namely, that most of these cases are ones that, to secure satisfactory results, should have been treated ten, twenty or thirty years before. Ankyloses of the stapes has already taken place to a greater or less extent, or retraction and fixation of the drum membrane have already occurred, and it is unreasonable to expect that the breaking up of adhesions at the pharyngeal mouth of the Eustachian tube at this late date will do any good. Nevertheless, if it will do good we want to find it out. In my hands, it has not been very successful and I can not see why it should be. These adhesions are almost invariably attached to the posterior lobe of the Eustachian os. Most of these tubes are already found thoroughly open, as may be proven by Eustachian catheterization. Breaking up these adhesions and the operative procedures about the naso-pharynx does in some cases do good in other ways. In the first place we get a certain amount of hemorrhage, and hemorrhage in these cases does a certain amount of temporary good in that the tinnitus is thereby lessened, and then there is sometimes a helpful psychic element entering into

the case. There is nearly always present in the naso-pharynx of these cases a pre-disposition to local infection which is handed down from childhood. These are invariably cases that are better or worse, because each attack of naso-pharyngitis enables new infection to take place. Such operations as Dr. Logan has described will prevent the acute attacks of naso-pharyngeal inflammation and in this way chiefly will they help to make the individual better. I do not condemn anything that Dr. Logan has said, but I do believe we ought not to give the impression that the cure of these old chronic middle ear diseases will be brought about by the operation advocated by the essayist.

Dr. G. Hudson Makuen, Philadelphia:—Some years ago I had a little experience in my own practice which impressed me with the fact that intranasal conditions do have a very indirect influence upon middle ear conditions. I had a slight nasal spur with intranasal pressure and accompanying it chronic attacks of fulness in the corresponding ear and a tendency toward attacks of catarrh. The spur was removed, pressure relieved, and in fifteen years I have had absolutely no return of either of these distressing symptoms. I want to say also that my experience coincides entirely with that of Dr. Logan in relation to post nasal infections. Recently I operated upon a man for another purpose, and accidentally I put my finger in the vault and broke up some of these adhesions and curetted only with the finger nail what I found in the fossa of Rosenmüller, and to my great surprise the hardness of hearing, which had distressed this man for many years, was greatly relieved. His hearing was at least twenty-five per cent. better than it had been for years, and I would like to mention a little scheme that I have adopted in all my adenectomies of recent years, that is to put my finger into the vault before the adenoid is removed and thoroughly clean out the vault with my finger before removing the growth; that is the time to do it, because you can then do it more thoroughly and completely and remove the adenoid more completely.

Dr. J. Payson Clark, Boston:—I was very much interested in Dr. Logan's paper. It seems to me, as I understand him, that he advocates an operation for removal of lymphoid tissue from the pharynx in all cases of adults or children where there is simply an inflammation of lymphoid tissue without any definite adenoid enlargement causing the symptoms. I consider that procedure very radical. It seems to me there are a great many cases of inflammation of lymphoid tissue for which much can be done by medicinal applications, and I am sure that I have had a great many cases that have been cured by these means. I may have misunderstood Dr. Logan, and if so my remarks are not in order.

One other point in regard to the pharyngeal bursa. This bursa is a depression or pouch of greater or less depth in the vault of the pharynx. This depression or pouch remains to show the place where the hypophysis or pituitary body was separated from the ectoderm in foetal life.

Dr. E. P. Emerson (by invitation):—I do not think that any one, especially after listening to this very able and instructive symposium, would consider Rosenmüller's fossae accountable for all diseases of the middle ear. I am exceedingly gratified, however, that so much emphasis has been laid upon this particular exciting cause. If we take adult cases without regard to age, we will be surprised to find, not as Dr. Barnhill has suggested, simple bands in the fossae connecting the Eustachian tube with the pharyngeal wall, but large amounts of degenerative tissue in the depth of the fossae. Those cases, in which it is always present without regard to age, are those of unilateral deafness, accompanied by low pitch tinnitus, and which are affected by climatic changes. After examining several hundred cases during the last five years, I find that you can predict the ear involved, by the condition of the corresponding fossa. This seems a strong point in showing the relationship which the tissue in the fossa has to the diseased middle ear. These patients complain not so much of their degree of deafness,

as of their fluctuation in hearing, and of the tinnitus. The low pitched tinnitus is influenced by clearing out of this fossa. These cases have been overlooked in adults, because they cannot be recognized by a posterior mirror, and we have not been in the habit of making a digital examination. Freeing the fossae will not absorb fibrous bands in the middle ear, or cure diseased ossicles. My experience has been, however, along the line which Dr. Leland has pointed out, that when these fossae are freed and the normal physiological action of the palatine muscles restored, there is a decided beneficial action from the influence of respiration, on the hearing. In these cases the catheter has been abused. There is one more point that I would like to add, and that is, after clearing out of the fossae, follow your cases until there is no danger of bands reforming.

Dr. B. A. Randall, Philadelphia:—There are one or two points which I wish to touch upon. This matter of the hysterical action of the muscles does not need to be further emphasized, except that it is constantly forgotten. In these cases physical massage and gymnastics are of an importance which cannot be too much emphasized, particularly when it is so easily carried out in any place, by anybody, unless by those who are the most in need of it. Then we must bear in mind in relation to nasal respiration, the course of the inspired and expired air which is through the vault of the nose. Small amounts of protrusion can have so much bearing on the subject, while spurs can have so little, in spite of all that is written by authorities on the subject. These spurs are not in the lower portion of the nasal chamber. It is impossible in my opinion to have adenoid removal at all permanent, however far reaching the operation, even cutting down to the muscle or underlying fossa, if you have a stuffed nose in front of it. I was very fortunate in having been brought up under the teaching of Harrison Allen, when some of these matters which are being constantly rediscovered, like the importance of the fossa of Rosen-

müller, were drilled into me twenty years ago. I think that this matter deserves considerable consideration, although I have never yet seen any brilliant results from the clearing out of this fossa. You find conditions there which under treatment, and I have seen many cases, where the very shrunken adenoid masses no longer mechanically obstructive have been removed with marked improvement. I must confess there is some advantage in being adapted to one's environment. Philadelphia is exceedingly slow, but some are old fashioned enough to find otosclerosis improving under treatment of middle ear disease.

Dr. George A. Leland, of Boston, (in closing):—I wish only to add, as was said in my paper, that adhesions which occur in the middle ear when too firm probably cannot be influenced by these physiological movements, but when they are not too great then the continual action of these movements does produce some effect. It is often the case that improvement in the hearing takes a shorter time than the coming on of deafness. That is another point in my argument that these lesions should be stopped at the beginning. It has been said that the tubes may be easily inflated by condensed air through the Politzer bag and otherwise; that is true enough, but this does not mean that they are freely enough open to be influenced by these continuous gentle physiological movements. I believe that the membrana tympani can be made flexible, and the adhesions also in many cases, by the natural movements described.

Dr. N. H. Pierce, Chicago, (in closing):—I have nothing to add regarding this special subject, but I am going to say something about a matter which came up in the first meeting of the Laryngological Association, namely, whether a case of hydrops of the antrum can cause ectasis of the walls of the maxillary sinus, or whenever we have a bulging of the maxillary sinus do we invariably have a congenital cause? Now, in the case of insufficient ventilation of the middle

ear we have a partial vacuum plus atmospheric pressure in the external auditory canal. We can have this go on for a considerable length of time, in fact until the pressure atrophy caused by this compression may cause complete atrophy of the tympanic membrane, so that almost every cavity will be obliterated, without serous exudate in the middle ear. Hydrops of the antrum occurs from the same cause, insufficient ventilation, either from congenital or inflammatory closure of the ostium. The air is absorbed and the pressure vacuum is established and the resistance of the tissue is overcome and the serum squeezed out into the cavity of the antrum. I ask now whether it is reasonable to think that this fluid, which is caused by the pressure vacuum could be produced by this pressure vacuum to such an extent as to dilate the maxillary sinus.

Dr. James E. Logan, Kansas City, (in closing) :—I would like to say in regard to Dr. Crockett's remarks that I agree with him in toto, and I believe its importance is clearly recognized. Dr. Richards' use of the finger cap I find objectionable. I cannot feel as sensitively with it as without it; I believe my finger can be made absolutely clean and no more objectionable than would be the finger stall.

With regard to Dr. Fridenberg's suggestion I would simply say that these cases I thought of interest out of 284 cases, and I showed these plates to show how much of the hypertrophy existed in the fossa of Rosenmüller, and how little existed in the vault of the pharynx, and how very important it was to remove that mass, even though it does not show the involvement of the Eustachian canal. This condition would be hard to draw as I think it should be done.

The question of compression or involvement of the tympanum was not shown because I could not have it accurately drawn. It was not a question of compression, but inflammation, extending from this mass into the tissue surrounding it. I agree with Dr. Shambaugh in what he has said, and believe in the importance of what Dr. Emerson says of

the differentiation between otosclerosis and sclerosis. I think this little operation I have suggested, this clearing out of the vault, is simply a means of clearing up a cause. I do not believe these cases are remediable by that alone, but I do know that they are relieved. The question of otosclerosis and fixation of the stapes is cleared up for us because you do realize the contracture of the tympanum. Upon that depends your prognosis, but I would like to say this in regard to prognosis, I never make any statement except, that unless this mass is removed, the condition will not be improved.

With regard to Dr. Simpson's remarks relative to atrophy, I think by the method of stripping I have used, I have broken up this mass, and I have found no atrophy in the cases I have operated upon thus far. In regard to the point brought out by Dr. Clark, I will say to remove this growth first, if it is possible to detect it in the swollen mass, and afterward to carry on the after treatment. I was glad to hear Dr. Makuen refer to the case in which after breaking up the adhesions hearing improved. I would like to have shown one or two cases of what appeared to be otosclerosis in which I got some improvement, but not enough increase in hearing to call it recovery. I believe that the operation and the after treatment will at least prevent an increase of this condition and will be of benefit. You can help to stop the disease, and then nature will act as a great help in the patient's future improvement.

Dr. Francis R. Packard, Philadelphia, (in closing):—I think we are all practically agreed upon the most important points. I do not think any one would claim he could cure middle ear diseases by the removal of conditions in the naso-pharynx. My remarks are intended merely to emphasize that, in spite of the fact that the naso-pharynx is the most important site of origin of middle ear disease, its examination is very frequently overlooked or is not properly done.

EXHIBITION OF A SPECIMEN. SEQUESTRUM OF ENTIRE PETROSA.

By T. PASSMORE BERENS, M. D., New York, N. Y.

Female child, aged five, visited the Manhattan Eye, Ear and Throat Hospital April 20, 1909, with the following history:

She had always been well until one year before, when she had a severe attack of scarlet fever, accompanied with suppuration of the left middle ear. The suppuration continued and an abscess developed in the neck. This abscess was opened by her family physician, who found considerable difficulty in having it heal,—several months being required. Facial paralysis developed about six months ago, and is now complete on the affected side.

Examination: The child presented a fairly healthy appearance, except for the well-marked facial paralysis on the left side. The external auditory canal was filled with a mass of granulation tissue which was protruding into the concha. A probe discovered dead bone in the canal, and a large flake of the canal-wall was removed. Further investigation revealed dead bone in the middle ear.

Under ether anaesthesia the usual mastoid incision was made. The cortex of the mastoid was absent, except at the extreme tip, where there was a wall of extremely hard bone, perhaps 1-3 inch in thickness. This wall extended upward for 2-3 inch and represented the posterior and inferior limit of the mastoid process. A large mass of dead bone occupied the mastoid, and on manipulation was found to be quite loose, and represented the remains of the mastoid cells. Most of the posterior wall of the external auditory canal was absent. The superior wall of the canal was healthy. A radical operation was performed. An enormous mass of

granulation tissue was removed from the canal and from the middle ear. Its removal disclosed dead bone throughout the middle ear. Thumb forceps were used to lift the sequestrum, which broke into two pieces. You will note that this sequestrum consists of a considerable mass of mastoid cells and all of the petrosa. The semi-circular canals, the cochlea, the vestibule, the internal auditory canal and the remains of the canal for the carotid artery were plainly discernible. Removal of this sequestrum disclosed a large cavity lined with thick, unhealthy granulation tissue. There was no vestige of the petrosal sinuses; the region of the lateral sinus was so thickly covered with granulations which it was deemed inadvisable to disturb, that the sinus itself was not seen. Pulsation of the carotid

A Mastoid portion.
B Petrosa showing internal auditory canal.

artery could not be felt. On the removal of the unhealthy granulation tissue remnants of the auditory nerve were plainly seen in a highly putrid condition. These remnants were removed with scissors. The unhealthy granulation tissue was removed only down to granulations that seemed to be fairly firm. The wound was packed with iodoform gauze and the patient returned to bed in good condition.

While the patient remained in the hospital she did well, was up playing with the other children for three weeks, and the wound was closing in nicely. Since leaving the hospital, against advice, I have learned that she has done badly, but the particulars are not at hand.

Discussion.

Dr. Norval H. Pierce, Chicago:—What became of the cartoid artery; was it thrombosed?

Dr. Berens:—I was afraid to remove too much tissue; could not feel the pulsation of the artery and suppose it was destroyed.

Dr. B. A. Randall, Philadelphia:—I had a case some years ago where the posterior wall of the sinus had granulations upon it and there was loose bone. I felt it advisable to wait a while for the throwing off of the sequestrum, but my resident a little later presented me with the sequestrum. When I showed him a considerable part of the groove of the cartoid his hair raised and he thought I had not been rash in my advice.

Dr. N. H. Pierce, Chicago:—Exhibited an instrument for testing the hearing that may be left after injury to the labyrinth.

Dr. Berens:—This ear from which this sequestrum came could not hear any more than a foot that has been amputated could walk.

Dr. Pierce:—Of course none of us believe that an ear without a labyrinth can hear.

ON THE SIGNIFICANCE OF CERTAIN LABYRINTH SYMPTOMS.

By GEO. E. SHAMBAUGH, M. D., Chicago, Ill.

A diagnosis of the various pathological processes which involve the inner ear presents often a difficult problem. This diagnosis is based largely on the occurrence of certain labyrinth symptoms regarding the interpretation of which there exists oftimes much uncertainty and confusion. The object of this paper is to discuss the significance of certain characteristic labyrinth symptoms in their relation to the diseases involving the inner ear.

Pathological processes involving the inner ear give rise to symptoms resulting from irritation and those resulting from loss of function. The symptoms of irritation are tinnitus aurium and vertigo. The symptoms arising from loss of function are deafness and disturbance of equilibrium.

Whether in a particular case the clinical symptoms of irritation, or whether those arising from loss of function predominate, depends largely on whether the condition is an acute process, or whether it is a long standing chronic process. In case of chronic internal ear disease, the symptoms resulting from loss of function predominate. In these cases deafness is usually the most conspicuous symptom, although tinnitus is often present. The absence of disturbance of equilibrium is in part due to the fact that often in these chronic cases the process is limited to the cochlear branch of the auditory nerve. But even in those cases where the vestibular nerve is also involved, after the acute symptoms of irritation subside, that is, after the vertigo disappears, the disturbance of equilibrium can be detected, usually, only by careful methods of examination. On the other hand, in the cases of acute involvement of the inner ear the symptoms arising from irri-

tation, that is, tinnitus and vertigo, are the most conspicuous. The combination of symptoms of irritation with those of loss of function, such as must always occur when an acute process involves the distribution of the auditory nerve, gives rise to the typical clinical picture of the so-called Meniere-symptom-complex. That is the occurrence of an attack of deafness and tinnitus, together with disturbance of equilibrium and vertigo. In cases where the vertigo is at all severe, nausea and vomiting will intervene, and in those cases where the onset has been sufficiently sudden and severe to produce the necessary shock, there may occasionally be a temporary loss of conscience. The Meniere-symptom-complex, in a mild or a severe form, indicates an acute process involving both the cochlear and the vestibular divisions of the auditory nerve. It does not, of course, signify any disease in particular, since any process involving acutely either the terminal distribution of the auditory nerve in the labyrinth or the nerve trunk itself will give rise to this symptom complex.

That cases will occur where the acute process will be limited to either the cochlear or the vestibular parts is, of course, to be expected. Here the complete picture of the Meniere-symptom-complex will be wanting. For example, when the cochlea alone is involved, the symptoms of tinnitus and deafness will occur, and when the vestibular part alone is involved, only vertigo and disturbance of equilibrium will arise, with perhaps nausea and vomiting. Cases of acute involvement of the inner ear, in which the disease is limited to either the cochlea or the vestibular parts, are not so uncommon. The processes other than the acute suppuration of the labyrinth that involve the inner ear in this way, appear to affect the cochlear part more frequently than the vestibular part. On the other hand, it should be kept in mind that the symptoms arising from an acute process limited to the vestibular division, are often referred to some other source than the labyrinth, simply because, in the absence of any disturbance of hearing, the ear is often not suspected.

In the development of the symptoms arising from an acute involvement of the inner ear, whether the process is one limited to the cochlear or to the vestibular parts, or whether both parts of the auditory nerve are involved, there are two distinct types of onset. In the one the onset is slow, requiring an appreciable time, occasionally several days before the symptoms are fully developed. This is the characteristic type of onset when the process is a neuritis of the auditory nerve, such as occurs from the toxic action of certain drugs, as quinine, salicylic acid, alcohol, tobacco, etc., or from an infection, such as Measles, Influenza, Typhoid, etc.

In the other type of onset of symptoms from an acute involvement of the inner ear, the condition develops suddenly. Often the patient will scarcely have time enough to take hold of something for support, and may even be thrown violently to the ground. It is, of course, only in such cases of sudden onset that the shock will prove severe enough to occasionally produce a temporary loss of consciousness. There are several pathological processes that are known to produce these sudden attacks of acute inner ear disease. One is the lodging of an embolus in the labyrinthine vessels. The arterial supply of the labyrinth, consisting of a single trunk is such that it is possible for a single embolus to shut off the arterial supply for the entire labyrinth, thus giving rise to the sudden onset of the complete Meniere-symptom-complex. On the other hand, the several parts of the labyrinth are supplied separately by branches of the labyrinthine artery which are in the character of end arteries, similar to the vessels supplying the cortex of the brain, so that it is possible for emboli lodging in these terminal arteries to affect separately the several end organs in the vestibule and semicircular canals, as well as the whole or even circumscribed areas of the organ of Corti in the cochlea. These anatomical facts explain the possibility of the occurrence of the sudden onset of symptoms limited either to the cochlea or to the vestibular parts of the laby-

rinth. An example of an embolus affecting only the cochlea in this way is the following case.

Mrs. M. (age 42) was confined February, '08, when she suffered from severe hemorrhage. Three days later she experienced a sudden onset of severe subjective noises and deafness in the left ear, which, on examination, appeared to be complete for all tones, and which became permanent. There was at no time any disturbance of equilibrium or vertigo. There was no history of previous ear trouble, and the membrana tympani were normal.

The circumscribed involvement of a separate area in the cochlea by an embolus lodging in the artery supplying the upper coil appears to be a possible explanation of the following case.

Mrs. B. (age 43), wife of a physician, no history of previous ear trouble, and with the membrana tympani both ears normal. She developed suddenly, December, '08, severe tinnitus and deafness in the left ear. There was no disturbance of equilibrium or vertigo when examined four months later. The hearing in the right ear was found normal. In the left ear there was a defect limited to the lower part of the scale. The defect was complete for all tones below A (55 d. v.), from A to e^2 all the forks of the Edelman series were heard, not as distinct tones, but more like a buzzing. A difference in pitch could scarcely be detected between the several forks in this part of the scale. All of these forks appeared, however, of a higher pitch than with the right ear. The Weber was lateralized in the right ear. When examined again one year after the onset, the right ear was still found to be normal. In the left ear the lower limit was at D (70 d. v.). Above D all the tones were heard distinctly, and of the same pitch as in the right ear. At the time of the first examination there was a defect in the left ear for the Galton whistle above 4. This was found to be the same when examined one year later. The calloric tests gave a normal vestibular reaction.

The sudden development of symptoms of acute internal

ear trouble in Cassion workers, has been shown to be due to gas emboli lodging in the labyrinth vessels.

There is another pathological lesion that has repeatedly been shown at autopsy to be responsible for the sudden onset of the Meniere-symptom-complex. This is a hemorrhage from the labyrinthine vessels. This lesion has been verified especially in cases of leukaemia, but also in other diseases, such as pernicious anaemia and acute nephritis. Recently it has been shown (F. Alexander and P. Manasse) that typical attacks of the sudden onset of the Meniere-symptom-complex in cases of chronic progressive labyrinthine deafness may be associated with multiple hemorrhages not only into the structures of the labyrinth, but into the trunk of the auditory nerve. It would seem probable that in other cases where there is a sudden onset of the symptoms of labyrinthine diseases without any evident cause, a vascular disturbance such as an embolus or a hemorrhage may be the cause. The actual proof will of course be slow in finding, since in the absence of some general fatal disease, such as leukaemia, it will be rare indeed that a postmortem examination will be possible soon enough after the occurrence of the symptoms to be of any value. There are cases where the sudden occurrence of the Meniere-symptom-complex terminates as rapidly as the onset, leaving no trace of disturbance behind. The symptoms in these cases can be accounted for most readily, it would seem, on the hypothesis of a vasomotor disturbance in the labyrinthine vessels, either an anaemia or a hyperaemia. Of course, the possibility of an hysterical factor must be considered in such cases.

The term Meniere's disease is often applied to those cases of internal ear trouble where there has been a sudden onset of the Meniere-symptom-complex due to a hemorrhage in the labyrinth, or an embolus in the labyrinthine vessels. By some this term should be applied only to those cases where there is no history of previous ear trouble. By others it has been used loosely in all cases where the Meniere-symptom-complex is found. Some recent writers

would drop the term Meniere's disease completely from our vocabulary, as well as the term Meniere-symptom-complex. This latter term, as has been pointed out, is but a concise expression for the symptoms resulting from an acute process involving the cochlear and the vestibular parts of the inner ear, and as such I can see no objection to its use. A possible objection to the use of the term Meniere's disease for those cases where the sudden occurrence of labyrinth symptoms is due to a hemorrhage or an embolus in the labyrinthine vessels rests on the question whether the diagnosis of this particular lesion can be made clinically. It does not matter, provided the diagnosis of hemorrhage or emboli can be made, whether the lesion develops in an ear previously quite normal or in one already the seat of disease. No confusion in the diagnosis of this condition will be occasioned today by the extension of an infection to the labyrinth from a purulent otitis media, or by the involvement of the labyrinth in cerebrospinal meningitis. It has been suggested (Siebenmann) that the sudden onset of labyrinth symptoms may also occur in case of neuritis of the acoustic nerve (fulminating type). If this view be accepted, then it would appear impossible to distinguish, in many of these cases, a neuritis of the acoustic nerve from an embolus or a hemorrhage in the labyrinth vessels. The occurrence of a defect limited to the lower part of the tone scale, due presumably to a lesion near the apex of the cochlea, would seem to indicate a vascular lesion rather than a neuritis of the acoustic nerve. The occurrence also of such a symptom as diplacousis would indicate a lesion in the peripheral apparatus in the cochlea rather than a neuritis of the acoustic. In general, the sudden onset of labyrinth symptoms, or the sudden exacerbation of these symptoms, suggests a process in the labyrinth rather than in the acoustic nerve.

The following conclusions may be expressed:

1. The occurrence of the Meniere-symptom-complex, that is, the onset of tinnitus and deafness, together with vertigo and loss of equilibrium, indicates an acute process involving the inner ear.

2. An acute process involving the inner ear may be limited to the cochlea or to the vestibule and semicircular canals. This can be accounted for by a separate involvement of the cochlear or the vestibular divisions of the auditory nerve, or by a lesion in the peripheral blood vessels which supply the several parts of the labyrinth as end arteries.

3. The sudden onset of labyrinth symptoms may be occasioned by an embolus or a hemorrhage in the labyrinth vessels (true Meniere's disease).

4. The labyrinth symptoms resulting from an acute neuritis of the acoustic nerve develops often by a more or less gradual onset.

5. In cases presenting a sudden onset of acute labyrinth symptoms a diagnosis between a lesion in the vascular supply of the labyrinth and a possible fulminating type of neuritis of the acoustic nerve may often be impossible, except where there are associated certain symptoms characteristic of a lesion in the peripheral apparatus in the cochlea, such as diplacousis or a defect in hearing circumscribed to parts of the tone scale other than at the upper limit, or finally, where a general disease like leukaemia makes the presumption in favor of a hemorrhage.

Discussion.

Dr. Percy Fridenberg, New York:—I would like to say a word or two in regard to the tests of labyrinthine function. The caloric test is open to some misinterpretation. One source of error is that we may not only have the caloric effect on the middle ear and labyrinth but also a mechanical effect if the fluid is injected under pressure. If the test is applied with a piston syringe, as I have seen it done, we will get characteristic reaction when there is no disease of the semicircular canals whatever. It occurs in perfectly normal ears. It is not necessary to have the water extremely cold, water at the temperature of the room is generally

about thirty degrees lower than normal blood temperature which is sufficient. The ordinary syringe may be used and the fluid allowed to trickle into the ear.

Rotational tests we are not able to apply and until greater experience is had we can get little from them. It depends upon whether the subjects are in the habit of rotating, reversing in dancing, are right or left handed, subject to dizziness, etc., a great deal.

The galvanic test is more valuable. As to spontaneous nystagmus, it is sometimes valuable as to cerebellar abscess but there are cases where it is faulty and gives no help whatever.

Dr. B. A. Randall, Philadelphia:—We must not forget mere serous invasion, which may exist without hemorrage, or without probability of being persistent. There are not a few cases which do not range themselves in the hysteric group which have symptoms of this sort. They are so persistent that we cannot prove anything else with regard to them and I have seen them at the same time so severe as to strike them down as if by hammer, and with no great loss of hearing resulting and the cases remain with differentiation between labyrinthine trouble and mild epilepsy still undecided. I have seen some cases where the employment of adrenalin, especially the dessicated gland, has done a great deal to steady the circulation and relieve the symptoms, which perhaps were merely vasomotor.

Dr. George E. Shambaugh, Chicago, (closing remarks):—It is growing more important that we pay close attention to the interpretation of labyrinth symptoms and to the diagnosis of labyrinth diseases because there has been opened up for us quite recently a comparatively new field of surgery in connection with labyrinthine suppuration. A misinterpretation of labyrinthine symptoms in a case where suppuration of the labyrinth is suspected may easily lead to the most serious results.

I had an opportunity quite recently to see a case where an operation was about to be undertaken for supposed suppuration of the labyrinth. The chief symptom on which the diagnosis was based was vertigo and disturbance of equilibrium. The case was one of hysterical vertigo. Another case was about to be operated on for internal ear complication presumably of a suppurative nature. It turned out to be a case of neuritis of the acoustic nerve, and not a suppurative case at all. To operate and open up the labyrinth in either of these cases would be much more serious than to do the same for a labyrinth actually the seat of a suppuration, because in the latter nature has provided a protection against meningitis which is not found in a non-suppurative case.

A STUDY OF SOME CASTS OF THE INFANTILE PHARYNX WITH SPECIAL REFERENCE TO THE EUSTACHIAN TUBES.

By WILLIAM C. BRAISLIN, M. D., Brooklyn, N. Y.

The very considerable differences in relative size and shape between the pharyngeal cavity of infancy and of adult life form the basis for the following remarks:

Casts of metal or plaster are found useful in demonstrating the topography of this region. For purposes of photography those of the latter material, though more fragile, have superior advantages.

The photographs accompanying this paper were made from casts of fresh uninjected material as well as from specimens hardened in formalin solution. In order to demonstrate certain details, photographs of the tissues themselves have also been used.

The naso or rhino-pharynx is generally understood to include that portion of the respiratory tract posterior to the nares and above the level of the soft palate. It is so treated here. This tract is meant in all mention of the pharynx, naso-pharynx or rhino-pharynx in the present paper.

An examination of the pharynx of the new-born reveals a cavity with its long axis in the horizontal, rather than the vertical plane as in the adult. The long diameter of the infantile pharynx is antero-posterior rather than supero-inferior. The cavity is relatively low and elongated, wide and flattened from above downward, approaching more nearly the shape of certain mammalia of a lower type than that of the human adult. The roof or vault of the infantile pharynx is nearly rectangular. On its surface is distributed the pad of lymphoid glandular tissue arranged in rather

prominent folds. The folds diverge as from a centre, the outer ones to the full width of the roof, and again converge toward the posterior edge of the nasal septum.

The pattern is fairly regular, though by no means constant. The rugae are distinctly visible in all the new-born specimens studied except in one very much emaciated child, where the vault was perfectly smooth and free from rugae. In fat infants they seem more than usually prominent. They have been noted well developed in the seven-months

FIG. 1.

Naso-pharynx of new born, its long axis more nearly horizontal than in the adult. The post-septal border is also more nearly horizontal than that of the adult. (Slightly reduced.)

embryo and may often doubtless be visible, even on gross dissection, earlier. These folds usually retain their characteristic pattern when hypertrophied (adenoids), and are often thus removed. Masses taken away by the sharp curette, especially, frequently exhibit the characteristically shaped rugae, with deep creases between. At the centre of the pharynx where the folds converge in four of my speci-

mens was seen a somewhat duct-like opening (the pharyngeal bursa*).

Behind the pad of glandular tissue which in the new-born extends but little posteriorily to the center of the roof of the pharynx, the mucous membrane is smoothly continuous with that lining the posterior and side walls. This portion of the mucous membrane after preservation in formalin solution, assumes fine transverse rugae in both infants and adults, being occasioned doubtless by the contraction of the fibres of the superior constrictor muscle. The anterior wall, composed of the posterior nares and septum differs

FIG. 2.

Casts of new-born pharynges, superior aspects. In left cast the rugae are regular, in right (cast prolonged into posterior nares) the rugae are irregular.

from the adult in the following particulars. The posterior nares are wider and shallower, approaching in shape a pair of equilateral triangles placed on their bases, side by side, the septum like a widely spread V between them. (See fig. 4).

The infantile post-septal border arches very gradually from the horizontal plane at its superior attachment until near its inferior attachment when it suddenly angles down-

* Openings of this character may sometimes be observed in older children elsewhere in the pharynx. The writer has seen a case where several such openings were visible in a youth of seventeen years apparently as a result of inflammatory changes in unoperated adenoids.

ward to the articulation with the horizontal plates of the palate bones.

The lateral walls in infancy show perhaps the widest differences from the adult of any of its boundaries, exhibiting the characteristics of this shallow, and relatively long cavity. The most conspicuous landmarks are the prominences of the cartilaginous extremities of the Eustachian tubes which stand out sharply from the side walls, separating the depression of the pharyngeal mouth of the tube in front from that of the longer, more extensive and equally deep depression, forming the fossa of Rosenmüller, behind. The prominences of the cartilage receive the direct impingement of the air current, inspired through the nares and in some degree deflect it across the mouths of the tubes

FIG. 3.

Cast of new-born naso-pharynx, lateral and superior surfaces. T are the projections into mouths of Eustachian tubes. R of Rosenmüller's fossae. Elongated projections at left ends of cast are the extensions into the posterior nares, and indentations at the extremities of these are made by the posterior ends of the lower and middle turbinated bodies.

below, and against the roof of glandular tissue above. In the new-born the Eustachian cartilages are crowded closely to the roof of the naso-pharynx. They narrow the cavity somewhat from side to side. Anteriorly to, and below, the cartilaginous prominences, at the depressions of the mouths of the tubes and behind and above them (fossæ of Rosenmüller), the cavity of the infantile naso-pharynx reaches its extreme width. The depressions created by the mouths of the tubes considerably widen its transverse diameter at this

point, and this is likewise the part of the naso-pharyngeal cavity of the least vertical diameter.

The mouths of the tube lie, relatively to the septum, more posteriorily in the infant than in the adult. Instead of being on a direct plane with the septal edge as in the adult they are ⅛ inch posterior to it. This discrepancy is due to the lesser development of the vomer in the new-born.

Traces of the salpingo-pharyngeal and the salpingo-palatine folds, one or both, may be noticed in the infantile pharynx. These follow the long axis of the cavity in both

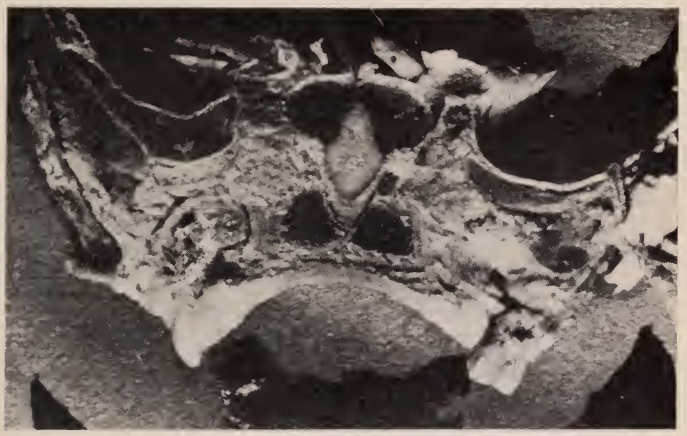

FIG. 4.

Transverse vertical section just anterior to opening of posterior nares showing their triangular appearance.

cases so that they extend more nearly horizontally in the new-born than, as in the adult, vertically.

The mouths of the Eustachian tube are relatively more nearly on a level with the floor of the nares than in the adult. They are bounded above by the prominences of the Eustachian cartilages while the lower lip merges into the floor of the cavity (soft palate). The muscles underlying the mucous membrane at this point, the levator and tensor

palati, are both relatively well developed; both, however, taking more nearly horizontal than vertical directions than in the adult, from origins to attachments, due, in part, to the lack of development of the pterygoid processes of the sphenoid and to the inferior depth of the cavity of the naso-pharynx in the infant.

The floor of the pharynx of the new-born compares closely with that of the adult. Its palatal portion is of greater diameter, antero-posteriorly. This is due to the vomer being relatively smaller and more anteriorly placed in the infant and the hard plate likewise relatively shorter, antero-posteriorly.

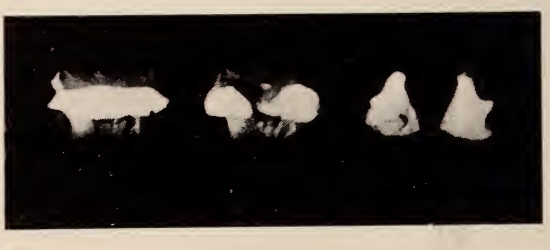

FIG. 5.

Vertical cross-sections through three casts of naso-pharynx of new-born (slightly enlarged). Figure on the left, at plane of mouths of Eustachian tubes; middle figure, at plane of posterior edge of septum; figure at right represents a cross-section within posterior nares.

The differences in the form of the infantile and adult naso-pharynx depend directly and primarily on the bony framework of the surrounding structures so that it is necessary to refer briefly to these, in order to elucidate the main causes of differences of the size and shape of the naso-pharyngeal cavity of the new-born.

The sphenoid bone presents at birth little evidence of the subsequently marked development of the pterygoid processes of the adult. The vertical plates of the palate bones are likewise very short. The vomer, which in adult life extends its superior articulation to the posterior edge of the

body of the sphenoid, articulates in the new-born with only the anterior half of the inferior surface of the sphenoid, in other words, it is relatively as well as actually smaller in the infant. The ethmoid, together with the bones of the face, have yet to undergo the development which increases so greatly the nasal mucous surface.

FIG. 6.

Cross-section of the pharyngeal mouth of the Eustachian tube. The darker tissue (enlarged 7 diameters). Author's specimen. The line of darker tissue at the left shows the Eustachian cartilage divided at its anterior, free, extremity.

The superior maxillary bones including the hard palate (palate processes) are relatively small.

In the new-born the nares are apparently of inferior relative importance, while the pharynx from its greater length

appears to be of relatively superior importance. It seems probable that in infancy a greater relative amount of the function of warming and moistening the respiratory stream is performed by the pharyngeal mucous and lymphoid tissues than by the nasal surfaces.

FIG. 7.

Cross-section of the tube, 2 cm. from pharyngeal mouth. Shows folds of mucous membrane within tube and relation to tensor muscles. Kindly photographed from the author's specimen by Dr. Edward L. Oatman. (Highly magnified.)

The dimensions of the infantile naso-pharynx (from the average measurements of my series of casts of twelve specimens) are, width at fossae of Rosenmüller and also at Eustachian tube mouths, 1.4 cm. (½ inch), depth, at plane of tubal orifices .4 cm. (3-16 inch) to .8 cm. (¼ inch) or

greater, posteriorly, as the floor, following the curve of the soft palate, descends. The horizontal portion of the vault is 1.5 cm. (⅝ inch) antero-posteriorly, and posteriorly, as it gradually curves downward into the posterior pharyngeal wall, the distance is as much greater. The horizontal portion of the floor of the naso-pharynx (upper surface of soft palate) is relatively longer, as the hard palate (palate

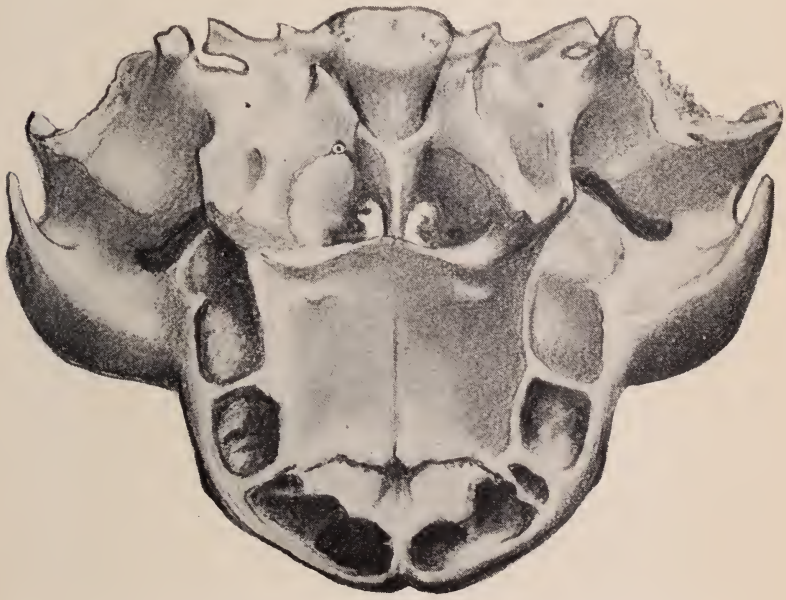

FIG. 8.

Sphenoid, superior maxillary and palate bones of infant. Inferior development of pterygoid processes and of vomer as compared with same structures in the adult. Drawing made for writer from specimen loaned by Dr. H. Von W. Schulte. Almost twice nat. size.

process of the superior maxillary) is relatively short, in the new-born than in the adult.

The antero-posterior attachment of the vomer to the body of the sphenoid in the adult extends nearly or quite, to the posterior edge of body of sphenoid. In infants, it extends

across about ½ the body of the sphenoid, and the vaginal processes of the sphenoid do not enclose the vomer.

The shallow pharynx of the infant under five years, especially under three years, makes the use of any but specially adapted forceps for the removal of adenoids less applicable than in older children and adults. I believe that a curette is preferably employed, and as a result of experience, I think this should be broad, rather flat-bladed and quite sharp. If the blade is dull, little good will be accomplished and partly detached portions of the growth may remain.

The writer wishes to acknowledge his indebtedness to Dr. Jonathan Wright, Dr. C. Schradieck, Dr. E. L. Oatman, and others, for generous assistance rendered in the preparation of this paper.

Conclusions.

1. The naso-pharynx of the new-born is low, broad and relatively long. Its shallowness is due to the undeveloped state of the bones of the cranium, face and cervical vertebrae chiefly the pterygoid processes of the sphenoid, the palate bones, the palate processes of the superior maxillary bones (hard palate) and of the vomer.

2. The inferior development of the nasal cavities may be responsible for a transference of greater relative respiratory importance upon the pharyngeal tissues. This may perhaps account in part at least for the lymphoid tissue of the infant being the seat of a relatively greater degree of hypertrophy than in the adult. As age advances the growth of the bones of the cranium and face is very rapid, the vault of the naso-pharynx becoming higher.

In adult life the vault is higher and apparently more withdrawn from the direct air current, although if the tissues remain normal, the functions of warming and moistening the inspired air are here still in part performed.

3. The difference in structure of the naso-pharynx of the young infant indicates a somewhat different course of procedure in operations for the removal of adenoids. In infants of two or three years or younger, adenoid forceps are rarely applicable. It is believed that in children under five years, a Gottstein's curette or some modification of it, is preferable. A sharp, flat bladed and fairly wide instrument best meets the indication in the hand of the writer.

Discussion.

Dr. B. A. Randall, Philadelphia:—Suggested making the superiority of casts of fusible metal. If you make these metal casts of the adult pharynx, however, you can put ten dollars worth of metal into one of them and then they are fragile; but if you plate them you can melt out the fusible metal and have fairly strong and less expensive specimens. The same thing can be done with plaster casts by the use of plumbago. Some of these are so beautiful that I hope some means will be taken to perpetuate them.

Dr. Geo. E. Shambaugh:—I would congratulate the writer on his work. We can all see at once that the results of such work have more value than drawings, often made from one's imagination, where one thinks he sees a thing and sits down and draws it. This is much better and more accurate.

A NOTE ON EUSTACHIAN OBSTRUCTION.

By WILLIAM C. BRAISLIN, M. D., Brooklyn, N. Y.

The following note is the result of an effort on the part of the writer to differentiate obstruction or inflammation of the Eustachian tube from concurrent inflammation of the tympanic cavity. This naturally led to a careful inquiry from patients as to the presence of purely tubal symptoms in all kinds of ear diseases. Some of the conclusions reached, having proved of interest to the writer, are recorded.

Absolute occlusion of the tube is believed to be of extreme rarity. It is very much open to question whether those tubes which on Politzeration seem impermeable are entirely so. Bezold stated (1895) that he had not met with atresia of the tube in his autopsies.

In almost all cases of acute pharyngitis (and rhinitis) the mouths of the tubes are at least congested; they may be oedematous, and active inflammation may extend along their lining membrane. In lymphoid tissue hypertrophies, the tubes are more or less obstructed.

It is a matter of common observation in examining the ears of patients suffering with an ordinary "head-cold" to find that there is more or less congestion of the ear, noticeable in a diminution of the lustre of the membrana tympani. In these cases all subjective symptoms referable to the ears or tubes may be absent.

The Eustachian tube as a drainage way. The patency of the tube is usually sufficient to allow fluids, as blood, pus or serum to drain from the middle ear into the naso-pharynx. For example, the passage of blood into the throat and thence into the stomach is frequently noticed at operations on the mastoid, especially in the radical operation when the mucous membrane of the middle ear is freely curetted.

The Eustachian tube as a transmitter of sound. The tuning fork held in the open mouth is heard more distinctly in normal ears than when in front of the nostrils or the closed mouth, but not as distinctly as when held near the ear. Nor is the hearing of a fork held in the mouth increased when the external ears are held closed. A tuning fork held in front of the nostrils is not heard longer than when held at the back of the head.

The fact that a tuning fork held in the open mouth is heard longer and louder than when it is held in front of normally patent nostrils, does not indicate that sound waves travel through the tube more readily by this route, but that sonorous impressions are thus more directly transmitted to the bones of the head and their enclosed air spaces, and are thus by direct vibration transferred to the hearing organ.

A curious instance of voluntary deflation of the middle-ear occurred in the case of a physician recently treated, who had normal hearing. In childhood he found that he was able to diminish the intensity of loud sounds which were disagreeable to him, by a voluntary act performed thus: The act of yawning was simulated, but without opening the mouth. Then an indrawing of the breath resulted in a rarefication of the intratympanic atmosphere, causing the drum membrane to be drawn against the inner wall of the cavity, with resulting diminution of all auditory perceptions. In order to restore the hearing to normal the act was varied by contraction of the tensor muscles as before and by then auto-inflating the tubes.

Symptomatology. In early inflammations of the tubes with beginning obstruction, also, after the subsidence of more pronounced obstructions, and in many chronic forms of ear diseases as well, the symptom of the occurrence of a snapping sound in the ears on swallowing or on blowing the nose, is present. The presence of this symptom always means a definite condition, and is a certain indication of partial tubal obstruction. It means that there is a partial obstruction of the tube, but one easily overcome. The mere

contraction of the tensor and levator palati opens the tube sufficiently to restore wholly or partially to normal the atmosphere of the tympanic cavity. Though there may be some difference of opinion as to the exact cause of this snapping sound on swallowing, I believe it is chiefly due to the drawing apart of the walls of the tube through a greater or less part of its length by the contraction of the tensor and levator palati muscles.

In severe phases of obstruction of the tube no snapping sound occurs on swallowing or on moderate blowing of the nose. Severe blowing, autoinflation, Politzerization or catherterization may however momentarily restore the atmospheric balance. In the most severe forms of obstruction all these fail. Astringents applied to the pharyngeal mouths of the tube may aid in restoring the balance.

On investigating this phase of middle ear disease, I have been surprised, though it may not surprise others, to find how common is the occurrence of the loud, snapping sound referred to, in one or both ears, in various forms of chronic middle ear diseases, as in chronic catarrh and in the so-called mixed, middle and internal ear disease. I believe that inflammation of the tube alone may occur without involvement of the other parts of the ear as stated above; but, that more or less active inflammatory processes in the Eustachian tube co-exist with a large proportion of the non-suppurative ear diseases daily met with, may be inferred, from the frequent presence of symptoms referable to the tubes themselves. The following symptoms are more or less significant.

Snapping. A swelling of moderate or severe degree of the mucous membrane lining the tube impedes the passage of air into the tympanic cavity, where an apparently rapid absorption of air into the circulation is constantly occurring. Very mild degrees of obstruction are relieved by swallowing or pushing forward the lower jaw. When this occurs a sound, similar to that of the separation of the moistened finger and thumb, held in front of the meatus, is perceived.

This snapping sound made by the opening of the tube is heard more intensely when the swollen walls of the tube separate on blowing the nose or on autoinflation. In nearly all acute forms of ear diseases this symptom is more or less prominent and it also commonly accompanies exacerbations of chronic middle ear inflammation. It is an accompaniment of involvements of the tube in acute rhinitis and pharyngitis. Its presence in middle ear catarrh and sclerosis is taken by the writer as a sign of a continuing degeneration of the middle ear region, the cause of which should be sought for in the nose, pharynx or tonsils as well as in the tubes. It is a symptom frequently ignored by the patient, especially in chronic cases and must nearly always be inquired for, in order to determine its presence or absence. It is never present in normal tubes nor in abnormally patent tubes. It is not a prominent symptom in very markedly obstructed tubes and can not occur in absolute closure of the tubes. It appears to be common in pharyngitis with or without involvement of more than the pharyngeal mouths of the Eustachian tubes. It is hence a frequent precursor as well as an accompanying symptom of various diseases, though it has been observed to occur at intervals for a long time without the accompaniment of noticeable impairment of hearing. On the appearance of the latter symptom, the occurrence of snapping sounds in cases of gradually progressive ear disease may cease or may become less frequent, or the patient may be so used to it that it is rarely complained of.

This symptom of tubal obstruction (snapping) may continue or recur at intervals in all forms of non-suppurative middle ear diseases. Its irregular recurrence may indicate that these periods of obstruction of the tubes are partially or wholly responsible for the irregular course of the degenerative changes taking place in the ear.

Paracusis. A symptom often complained of in Eustachian obstruction, though I believe not pathognomonic, is a sense of fulness in the ears, with more or less impairment of

hearing (the latter may be absent) and a sound-sensation in speaking as if talking in a hollow space or into a barrel. Vertigo, usually slight, sometimes quite severe, may accompany this symptom. I am in the habit of associating these with a considerable degree of swelling of the tubal membrane. They disappear when due to tubal obstruction, on the disappearance of the acute symptoms of the latter. Recurrence may take place with each attack of acute inflammation in nose, pharynx and tubes.

Pain. Pain due to tubal inflammation is rarely present without inflammation of the tympanic cavity and I think can rarely be demonstrated as referable to the tube alone.

Pain in the Eustachian tube, however, is rarely located by patients. The discomfort of passing the Eustachian bougie is usually referred by the patient either to the ear or to the side of the throat. The objective symptoms may be slight or absent; though, if the obstruction is pronounced the retraction of the membrana tympani is very noticeable.

Itching. Two cases in which a sensation of itching seems clearly referable to tubal congestion are briefly reported.

1. Philip Kelly, twenty-five years old, has had impairment of hearing and tinitus for three months following a "cold." At first he had a great deal of snapping in his ears on swallowing or blowing the nose. Watch, Right 1-60. Left 1-120. An itching sensation felt in the throat. He has tried to relieve this by scraping it as far inside the back of the throat as he could reach with his finger nail. Extreme retraction of the drum membrane, slight congestion of vessels of drum.

2. Henry Molloy, twenty years of age, has had severe tinnitis for one week in both ears, following a salt-water bath. On the fourth day he had slight pain in the ear, but no disturbance of sleep. Previously there was snapping in the ears. At present he has a sensation of fullness in the ears. Tinnitus is noticeable in both ears and an itching apparently deep in the ears. The drum shows retraction and slight congestion of hammer vessels.

A sensation described as itching or "crawling" in the ears or tube is sometimes a symptom of tubal obstruction. Thus a lady of forty years (Everdell, July 31, '05,) who complained that she had at times a sensation in the ears as though there were something crawling in her ear, obtained relief for a time after each auto-inflation.

The tympanic cavity, however, does not maintain its integrity after the occurrence of pronounced obstruction of the tube and a reddening of the membrana tympani soon occurs.

Tinnitus. Diseases of the naso-pharynx and Eustachian tube are so admittedly causes of tinnitus that one accepts it axiomatically. That tinnitus is, frequently, directly referable to tubal congestion or inflammation, I think certain. It is a matter of observation that the inhaling of cigarette smoke may cause an immediate increase of tinnitus. An **initial** inhalation may cause this. As this may occur with the first inhalation and without swallowing or any act which would draw open the tube, it seems clear enough that the irritating effect of the smoke on the pharyngeal mouth of the tube is responsible for this. If irritation at the mouth of the tube may cause or increase tinnitus, it is proper to infer that irritation, congestion or inflammation of the deeper part of the tube may cause tinnitus. This is not a mooted point, but I have frequently found it difficult to refer tinnitus definitely to this region.

The symptom of a snapping sound heard by persons with moderate degree of obstruction of the tube on swallowing, blowing the nose, protruding the lower jaw and certain other methods of contracting the tensor and levator palati muscles, is of importance in indicating a continuing of the tubal trouble even after the existence of middle and internal ear disease of many years' standing. How much influence these continued or recurring obstructions of the tubes bear upon the progress of the trouble I am not prepared to say, but I believe it worth while to ascertain the presence or absence of this symptom, not only because its presence

indicates the need of treatment of the tube, but also in that it indicates a moderate degree of obstruction, rather tending to a favorable prognosis, other conditions being equal.

When snapping sounds are absent, I believe it indicates that there is no obstruction, as in some sclerotic or atrophic changes, or that the tube is so much obstructed that air is conducted to the tympanic cavity only with great difficulty. Further examination and tests easily reveal which of the two conditions is present.

The following table shows the considerable proportion of non-suppurative ear diseases in which the above symptom was found in a series of cases from a clinic in January.

Sex.	Age.	Disease and its duration.	Absence or presence of snapping sounds.	Remarks.
Male	69	o. m. c. c. 10 yrs.	Affirmative	Noticed at intervals only; more noticeable before treatment was begun.
Male	27	o. m. c. c. 5 yrs.	?	Mucus evacuated from tube on catheterizing.
Female	25	o. m. p. resid. 4 to 6 yrs.	Negative	Chronic pharyngitis present.
Female	65	o. m. c. c. 20 yrs.	Affirmative	Noticed on coughing as well on blowing the nose.
Female	—	o. m. c. c. 5 yrs.	Affirmative	Snapping also occurs without effort on part of patient.
Male	26	o. m. c. c.	Negative	
Female	50	o. m. c. c.	Negative	
Female	40	o. m. p. resid.	Affirmative	Vertigo at times.
Female	29	o. m. c. c.	Negative	
Female	19	o. m. c. c.	Negative	Snapping occurred previously i. e. before treatment was instituted.
Male	49	ot. med. et int.	Negative	
Female	6	Day after recovery from o. m. p. a.	Negative	No sound noted on Politzerization.
Male	59	ot. med. et int.	Affirmative	
Female	39	Recovered from mastoid op.	Affirmative	

Sex.	Age.	Disease and its duration.	Absence or presence of snapping sounds.	Remarks.
Male	40	Tubal catarrh	Affirmative	States snapping is almost continuous. Is a cigar maker.
Female	20	o. m. scl. 5 yrs.	Affirmative	At times not noticeable.
Male	43	o. m. c. c.	Affirmative	
Male	52	ot. med. et int.	?	Formerly much snapping. At present none; but hearing is worse than when snapping occurred.

The evidence of the presence of tubal obstruction in chronic middle ear diseases indicates a need for the treatment of this important complication. It may be possible to do little or nothing for the middle ear diseases other than that affecting the tube alone, which as a rule is tractable. Treatment directed to the relief of tubal obstruction alone, has a positive effect in preventing or checking the progress of diseases affecting other portions of the sound conducting apparatus.

PARTIAL BIBLIOGRAPHY OF RECENT PAPERS RELATING TO THE EUSTACHIAN TUBE.

By WILLIAM C. BRAISLIN, M. D., Brooklyn, N. Y.

In the preparation of this list the reports on the progress of otology in the **Archives of Otology** have been freely utilized. This has enabled the writer to include several important papers in the list, the originals of which would not have been readily accessible, though in nearly all instances the references have been verified by direct examination of the papers themselves. In most cases of articles not written in English the titles are given in translation.

Allen, Harrison, On a New Method of Recording the Motions of the Soft Palate, Trans. of the Coll. of Physicians of Philadelphia, 3rd Series, Vol. VII., 1884, pp. 164-194. Allen observes that motions of the soft palate are transmitted to a rod passed along the floor of the nose into the pharynx, and, by means of a mechanism, these motions are recorded on a revolving cylinder in much the same way that the heart impulses are similarly recorded. It furnishes a positive basis of record of the motions of the soft palate. Tracings of various consonant and vowel sounds are figured and the method. Allen suggests its usefulness in paralysis of the palate, also possibly in stammering and in determining the degree of degeneration of the levator palate muscles in progressive dry catarrh.

Bacon, Gorham, The Anatomy, Physiology and Diseases of the Eustachian Tube. Reference Hand-book of the Medical Sciences, Vol. II., N. Y., 1886.

Ballenger, Wm. L., Tenotomy of the Tensor Tympani Muscle for the Relief of Deafness and Tinnitus. Laryngoscope VIII., 1900, pp. 85-89. The causes, indications for operative interference and contraindications for same are described.

Baratous, J., De electrolyse de la Galvanocaustique clinnique de la trompe d' Eustache. Revue Mens. de Laryng. 1884, No. 6, pp. 185-194 (on electrolysis or chemical galvanic cautery treatment of the Eustachian tube). B. refers to previous

attempts at the employment of electrolysis for obstructions of the tubes. He used a hard rubber catheter, at its enlarged end a hole, through which an electrode of silver or platinum is introduced. The second electrode is placed on the mastoid process. The current is used not stronger than five milliamperemeters nor longer than five minutes.

Bernoud, The Treatment of Deafness with Insufflations of Hot Air. Wiener Med. Blätter, XXVI., No. 39, 1904, pp. 475-477. The apparatus of Beck is used. The temperature of the air is regulated by an electrical heater. B. states that tinnitus disappears and a slight improvement in the hearing occurs from its use.

Bezold, Friedrich, A Case of Perforating Wound of the Organs of Hearing, in Court, and Subsequent Indictment of the Plaintiff for Supposed Simalation and Perjury, Berliner Klin. Wochenschrift, XX., No. 40, 1883, pp. 611-614. An individual received a shot wound of the left ear and brought suit against his assailant. This case was finally referred to B. for an expert opinion. He found that the injury (a cut inflicted by the defendant with a sharp-pointed knife in the neck) had penetrated the lumen of the tube causing a complete obstruction. A whalebone bougie met the obstruction 14 mm. within the mouth of the tube.

Bezold, F., Cholesteatoma, Perforation of Shrapnell's Membrane, and Occlusion of the Tube. An Aetiological Study. Translation by Dr. J. A. Spalding, Archives of Otology, XIX., 1890, pp. 232-254. A case was observed, post-mortem, of entire occlusion of the tympanic orifice, demonstrated viz., a marginal adhesion of the entire periphery of a perforation of Mt. existed. When the tube was inflated the rest of the Mt. puffed out all about the tubal orifice.

Blake, Clarence J., reviewing article by C. Nicoladoni, Beobachtung am Lebenden über die Bewegung der Tuba Eustachii, Arch. Ophthalmology and Otology, Vol. V., 1876, p. 122, states that he saw a case in which the normal Mt. was lacking and a thin cicatrix extended over the auditory canal. At the commencement of the act of swallowing this cicatrix was forcibly extended, falling into place at the end of the act.

Blau, L., Ein fall von kronischen Krampf des musculus Tensor Tympani ohni subjective Empfindung. Archiv. für Oherenheilkunde. Bd., XIII., p. 261. A 14 year old boy had sensation of pressure and temporary lancinating pains in his right

ear, increased resonance of his own voice, many subjective auditory perceptions, normal hearing. Spasmodic rapid motions of the Mt. were observable; also changes in the cone of light or extreme retractions of the Mt. not connected with respiration. Author attributes these to contractions of tensor tympani muscle.

Bonnier, M. P., The Tubo-tympanic Functions. Note, presented by Girard. Compt. rend, des Séances de la Soc. de Biol., Nov. 26, 1892, Feb. 18, 1893, April 15, 1893. "Descriptions of the manner in which the Eustachian tube, the tympanum, otoliths and otocysts assist in the functions of the apparatus of equilibrium."

Boulai, Voluntary Contraction of the Muscles of the Tympanic Membrane. Arch. internat. de Laryngol, etc., XIII., 2, 1893. Two cases observed where a distinctly audible crackling noise occurred, 30 times a minute. In one, the drum showed simultaneous vibrations. It could be produced voluntarily. B. considered it due to contractions of the tensor tympani.

Braislin, Wm. C., Eustachian Catarrh with Hyperinflation. Report of a case. Archives of Otology, XXXVII., 1908, pp. 215-216. Report of a case of extreme patency of the Eustachian tube, with an account of symptoms.

Brandegee, Wm. P., Tympanic Vertigo due to Obstruction within the Eustachian Tube. Arch. of Otology, XXX., 1901, pp. 205-213. The value of the electrolytic bougie is contended for. Over other forms of bougies B. claims the advantages of ease of manipulation, a minimum of pain, a minimum amount of trauma, thorough destruction of the stricture or occlusion and that the force to be used should be only that sufficient to insure good contact for the current.

Broich, F., Method of Direct Vibratory Massage of the Eustachian Tube and Its Effects on the Middle Ear. Report Germ. Otol. Soc. Arch. of Otol., XXVIII., 1899, pp. 388-389. Special probes introduced by way of the nose afford a direct massage of the pharyngeal ostium and the commencement of the tubal canal, as produced by Spoes' saw-handle driven by the electro-magnet.

Brunner, Gustav, On Alterations in the Hearing by One's Own Voice. Arch. Ophthal. and Otol., II. No. 1, 1870, pp. 107-126. Case of deafness (obstr. of tube) in which patient's own voice seems too loud in affected ear and very disagreeable. Inflation of air through tube caused cessation of symptoms. Regarded symptoms as not due to exudation of fluid in middle ear.

Brunner, G., On Vertigo Occurring in Affections of the Ear (Auditory Vertigo). Archives of Ophthalmology and Otology, II. No. 1, 1870, pp. 293-341. Vertigo may be occasioned by external pressure upon the drum-heads, by impulsions of air or liquids into the tympanic cavity through the Eustachian tubes or by the passage of a galvanic current through the ears. In injecting sulphate of zinc, one and one-half grains to the ounce, in right ear, his patient felt as if drawn to the direction of same side (right). [He says erroneously that the patient had a tendency to fall towards the right side. The patient makes an effort to overcome the apparent (to the patient) falling to the right and falls to the left side in such a case].

Bryant, W. Sohier, Demonstration of the Movements of the Eustachian Tube. Archives of Otology, XXXV., 1906, p. 564. (No details reported).

Bryant, W. Sohier, The Anatomy of the Child's Ear, Emphasizing Points of Practical Importance. Arch. of Otol., XXXIV., 1905, pp. 80-83. Bony portion of Eustachian tube absent at birth. Cribriform bone interposed between the floor of the tympanum and the carotid canal at the jugular fossa, which is below the tympanum, not behind. The mastoid is but slightly developed. The Eustachian tube is narrower and much shorter in the infant. It measures about 20 m. as against about 40 m. in the adult from the anterior border of the sulcus tympanicus. Its lumen at the isthmus is 2 m. as against 4 m. in the adult. It lies in a horizontal plane. Its angle with the median plane is about 45° and outwards as in the adult. At puberty it assumes the adult position. The relative position of the pharyngeal mouth of the Eust. tube to the posterior pharyngeal wall and the velum palati is farther forward and slightly lower down. The fossa of Rosenmüller does not form a deep depression till later in life. At birth the cavity of the middle ear, being filled with myxomatous tissue and detritus no air enters the tube immediately [but it is probable that the motion of the tensors produced by sucking, rapidly stimulates the opening of the tube].

Bryant, W. Sohier, The Eustachian Tube, Its Anatomy and Its Movements; With a Description of the Cartilages, Muscles, Fasciae, and the Fossa of Rosenmüller. Medical Record, LXXI., pp. 931-934, 1907. A detailed anatomical study of this region.

Buck, A. H., Unnatural Patency of the Eustachian Tube. Am. Jour. of Otology, II., 1880, pp. 203-205. A case related.

Bürkner, Report on the Treatment of Affections of the Tube. Report German Otol. Soc., 3rd meeting. Arch. of Otology, XXIV., 1895, pp. 59-62. Attention is called to the importance of catheterization when there is swelling in and mucous secretion of the tube, preferring it to Politzerization. The fear of causing infection of the middle ear in acute naso-pharyngeal or tubal affections is an exaggerated one, the neglect to inflate the middle ear causing the most harm. Gargling is regarded as an important measure in all simple tubal affections. Injections through the catheter are useful but should not be irritating. The use of the bougie in the tube is only indicated when catheterization causes no improvement. Medications and the use of the bougie are seldom productive of good results, though the vibration massage, by means of the bougie, by Urbantschitsch's method, is sometimes indicated. This is often painful. Politzer's method of external massage, on the other hand, is not. In atresia of the tube electrolysis and excision of the drum membrane and malleus are measures for consideration. Abnormal patulousness of the tube and abnormal conditions of the nose and naso-pharynx (ulcerative processes, synechiae, adenoid vegetations and hypertrophy of the tube) are important in their bearing. Galvano-cautery is not devoid of danger; acids are preferable. Discussion: Bezold agrees that the air douche should be used in acute affections of the tube. Catheterization is often preferable to Politzerization even in children. He has never found atresia of the tube in all his autopsies. The use of the bougie should be restricted. Bresgen recommends removal of nasal obstructions. Siebenmann does not consider nasal obstruction to have any etiologic significance in tubal disease. Apart from adenoids he has not found stenosis at autopsies. Barth and Fischenick believe nasal obstruction an etiological factor. Hartmann uses inflation as long as good results are obtained. He frequently uses injections. Cocaine acts well. Removal of nasal tumor may often be dispensed with if thin, short-beaked catheters are used.

Calhoun, A. W., Adenoid Vegetations, with Especial Reference to Their Influence Upon the Ear. Laryngoscope, VI., 1899, pp. 164-168. "Direct pressure upon the mouth of the tube rarely occurs, and yet its function is so frequently inter-

fered with that contraction or sinking of the drum-head follows. Perhaps the aural symptoms are due to the swelling of the mouth of the tube or an extension of the inflammatory process through the tube into the middle ear. Breathing through the mouth and the blocking of the post-nasal space change the air currents and alter the pressure about the mouth of the tube." The growth hinders the free action of the muscles controlling the lumen of the tube and permitting the entrance of air into the middle ear. This condition causes defects of hearing. This process sooner or later ends in chronic catarrhal otitis media with ankylosis of the ossicles. A suppurative inflammation frequently results from the presence of the mass.

Camerer, Foreign Body in the Eustachian Tube. Archiv. für Ohrenheilk, XL., 1896, pp. 63-64; Tubingen, 1894, Abs. A six-year-old boy fell from a wagon fifteen months previously. A piece of straw was driven into the mouth at that time but the visible portion was removed. One month later the right lateral pharyngeal region presented a swollen condition and otorrhea appeared in right ear. The latter continued a year with latterly aural hemorrhage. On the removal of offensive pus and granulations, roughened bone was detected and a movable body, which when removed proved to be a straw, 4½ cm. by 2 mm.

Citelli, S., On the Structure of the Human Eustachian Tube. Archivio italiano di otologia, XVI., 1905, pp. 404-418, pp. 441-452. The histology of the tube is given in detail.

Collet, On Salpingoscopy. Lyon Médical, 46, 1903, pp. 725-730. The Valentin Salpingoscope is recommended.

Dench, E. B., New Eustachian Bougie. Archives of Otology, XXI., 1892, pp. 149-156. A fine whalebone bougie is used. This is attached to the catheter by guides so that the lumen of the tube is not obstructed; at the same time the bougie may be passed into the tube at the same introduction as the catheter.

Denker, The Eustachian Tube of the Ant-Eater. Zeitschr. für Morphologie u. Antropologie, Bd. VIII., pp. 1-10. A paper regarding the comparative anatomy of Myrmecophaga jubata and M. didactyla.

Denker, Investigations of the Eustachian Tube of the Ant-Eater. Myrmecophaga, didactyla st M. jubata. Trans. Ger. Otol. Soc., 1904. In the first, no true tube exists, for a broad cavity surrounded by membranous walls occupies the place

of the tube. No bony tube. There is a round opening from the posterior and inferior corner of the tympanum to which the membranous canal is attached. In the latter species the large cavity is surrounded anteriorily by the tympanum and the pterygoid, posteriorily by a process of the basilar occipital.

Dennert, H., Zur Physiologie der Tuba Eustachii Grund einer Beobachtung von doppeleitigen organischen Verschluss der Raschenmendung derselben. Deutsche Zeitschrift für Pract. Medicin, No. 44, 1878. D. observed a patient with great syphilitic destruction of the naso-pharyngeal space. Cicatrix closed off the mouths of the Eustachian tube. Hearing was impaired and tinnitus present. During the act of swallowing both (most in left) Mt. were observed to sink in with subsequent outward motion. The same was observed when the nose was held during deglutition. D. thinks the phenomena due to a dilitation of the tube in the act of swallowing, producing a rarefication of the enclosed air.

De Rossi, Researches on the Micro-organisms in the Eustachian Tube of Healthy Individuals. Trans. 9th Internat. Med. Cong., pp. 859-862, 1887, Washington. In the secretions of the Eustachian tubes of twelve healthy individuals examined, the presence of germs was determined in six. None were of a pathologic character.

De Simoni, A., Intratympanic Injections in the Treatment of Chronic Middle Ear Catarrh. Arch. ital. di otologia, VII., p. 81. States good results followed use of vaseline oil and iodoform-ether through Eustachian tubes.

Duel, Arthur B., The Possibilities and Limitations of the Electroyltic Bougie in the Treatment of Chronic Catarrhal Otitis. Laryngoscope, XIII., 1903, pp. 523-532. D. thinks this method pre-eminent as a method of restoring patency of the tube. Best results are obtained by employing it sparingly and in connection with other forms of treatment. Intervals of two weeks should elapse before repetition. Caution is advised against using too often, too strong, and too hurriedly. Small bougies, small current, time and patience are advised.

Duel, A. B., The Rapid Dilation of the Eustachian Tube by Electrolysis. Laryngoscope, III., 1897, pp. 31-37. The electrolytic action of the negative pole of the galvanic current is employed. It is applied by one of four copper bougies, Nos. 3 to 6 French, mounted on No. 5 piano wire. They are passed through insulated silver catheters.

Duel, A. B., An Additional Note on the Treatment of Strictures of the Eustachian Tube by Electrolysis. Laryngoscope. IV., 1898, pp. 116-119. D. repeats that this treatment is not recommended for sclerosis but only for narrowing of the tube. 20 to 40 volts are required of 2 to 5 amperes. The operator should satisfy himself that the catheter is in place by the rhinoscopic mirror, or by successful inflation before the introduction of the gold bougie. The silver catheter is insulated by rubber dressing. The bougie should be pushed past the constriction slowly, occupying two minutes or more. The bougieing should not be repeated before a week or more but inflations should be continued. Many cases seem to be cured by one bougieing.

Duel, A. B., The Value of Electrolytic Dilitation of the Eustachian Tubes in Chronic Tubal Catarrh and Chronic Otitis Media. Amer. Jour. Med. Sciences, April, 1900. Many of the 50 reported cases were relieved or much improved as to the vertigo and tinnitus by restoration of the patency of the tubes. In nearly one-half the impairment of hearing was improved. The bougies are made of solid gold 2, 3 and 4 French scale. They should fit the tube snugly. The bougie is attached to the negative pole; the positive pole held in the patient's hand. Obstructions in the tube are overcome by using from 1 to 3 amperes of the current. After 20 seconds the bougie may be further introduced. It is not employed for more than five minutes at one time, and repeated at intervals of one week to one month, inflations being practised every other day. Two to four sittings are usually sufficient. A battery of 30 to 50 volts is employed.

Eitelberg, von A., Bougieing the Eustachian Tube. Tr. by Dr. Cornelius Williams. Archives of Otology, XIII., 1884, pp. 168-182. E. ascertained the average length of the Eustachian tube in adults as 36 to 44 mm. In the newly born the average is 19 mm. E. found that the penetration of the catheter amounted to from 6 to 11 mm. The longest tube measured among 15 fresh specimens was 48 mm.; the isthmus tubæ in this case was 28 mm. from the tubal orifice (pharyngeal end). The average distance from the ostium pharyngeum to the isthmus is 24 mm. The normal width of the isthmus is 1½ to 2 mm. In a case of chronic suppuration a bougie of large size (No. 4 Charrière) freely entered both tubes and could be made to

present in the auditory canals. The average length of the Eustachian tube as measured on the living patients was about 35 mm. Stricture of the middle part of the tube is exceedingly rare. In three cases E. succeeded in passing a bougie of larger size further into the tube than the smaller bougie would penetrate. He thinks this is due to the smaller tube being more readily engaged by folds of mucous membrane; also rotation on its long axis of a larger bougie more readily releases it. The infantile tube is both relatively and absolutely wider than the adult at its narrowest part, according to this author.

Eschweiler, On the Development of the Sound-Conducting Apparatus, with a Special Regard to the Tensor Tympani Muscle. Arch. für micr. Anat. XLIII., pp. 150-196.

Fischenick, Fr., The Treatment of Catarrhal Adhesive Processes in the Middle Ear with Intratubal Pilocarpine Injections. Berlin Klin. Wochenschr., Vol. 37, 1900; pp. 1033-1034. F. regards intratubal injections useful in sclerosis. Six to sixteen drops of a two per cent. solution are injected into each tube. Thirty to sixty sittings are given.

Ferguson, H. Lindo, An Improved Form of Eustachian Catheter. Archives of Otology, XIII., 1884, p. 296. A flexible tube bent to the proper curve is used. Into this is passed a straight stylet. It is used where obstructions forbidding the use of the ordinary catheter are met with. On passing the obstructions the style is withdrawn, whereupon the catheter assumes its proper shape.

Fournié, Edw., Du Role physiologique de la Trompe d'Eustache. Congrès periodique internat. d'otologie, 2d. mi., lan. 1880, pp. 119-126.

Goldstein, M. D., The Use and Abuse of the Eustachian Bougie. Laryngoscope, XIII., 1903, pp. 515-522. G. regards them of value in all chronic middle ear affections. Counter-indicated when patient complains of "fulness" after use or when hearing is dulled by them.

Gomperz, Typical Alterations of the Tension of the Membrana Tympani in Valvular Occlusions of the Eustachian Tubes. Rept. 1st meeting, Austrian Otol. Congress. Wiener Klin. Woch., IX., 1896, pp. 843-846. Bulgings of the postero-superior portion of the Mt. occur in otherwise normal Mt. and T. cavity. Symptoms occur-

ring are sensations of pressure, tension, slight subjective noises and occasional deafness. With use of Siegle's etoscope the postero-sup. quadrant follows its compressions or rarefactions but immediately jerks into its former bulged position. The most precautious blowing of the nose produces a feeling of air striking the Mt.. Therefore no impediment to the entrance of air exists, but one to its exit. In G.'s cases catarrh of the naso-pharynx, hypertrophy of the mucous membrane, polypi or suppuration of the accessory cavities were found.

Gradenigo, G., Diagnosis, Prognosis and Treatment of Progressive Deafness in Chronic Non-Suppurative Inflammation of the Middle Ear. Trans. by J. A. Spalding, Arch. Otol. XX., 1891, pp. 221-227. The contents of the tube were examined to ascertain the presence or absence of bacterial life in this disorder. The examination was negative, the only species of bacteria found were a few individuals of the bacteria of putrefaction commonly found in the air. (The same observations, elaborated, occur Centralbl f. Bacteriol, und Parasitenkunde, VIII., 1890, p. 225.

Gradle, H., On Headache from Overlooked Causes in the Naso-Pharynx and Ears. Jour. Am. Med. Assn., Vol. XI., Sept. 8, 1888, pp. 339-340. G. considers a certain type of continual headache, more commonly met in children, due to impaired patency of the Eustachian tubes.

Grubèr, J., On the Therapeutic Value of Injections of Medicated Solutions into the Eustachian Tube. Monatschirft für Ohrenheil, XIV, 1880, pp. 133-139. Solutions injected into the Eustachian tube soften, but do not dissolve mucus, so that it can then be more readily removed by catheter. They also benefit, by producing a new inflammation, in certain conditions. Gruber believes that injections detach synechiae extending from drum to tympanic walls or to ossicles even when air douche has not benefited.

Haike, H., Tuberculosis Ear Disease in Nurslings. Deutsche Med. Wochenschr. [Vol. 31] 1905, pp. 954-957. In five fatal cases the duration of the lesion was several weeks or months. In two cases, the possibility of the infective sputum entering through the Eustachian tubes could not be excluded. In the others the ear lesion was primary. The port of entry was the mouth or pharynx. Moreover, the author states, the tube may itself be the seat of disease in nurslings, while in adults it is merely the path of tubercular sputum.

Hammerschlag, V., Respiratory and Pulsatory Movements of the Drum Membrane. 1st Austrian Otol. Cong. Report, in Arch. of Otol., XXV., 1895, pp. 408-409. The investigations were made with an instrument similar to that of Mach, upon 4 healthy young individuals, in 30 observations. He found the Mt. exhibits constant movements, coincident with the systole of the heart.

Hammerschlag, V., On the Function of the Eustachian Tube. Arch. für Ohrenheilk, XLIII., 1897, p. 65, (a reply to Lucae's article in Arch. f. O.). He believes the middle ear and naso-pharynx are in open communication. [Hartman, in Arch. of Otol., XXVII., 1898, pp. 179-180 again shows the fallacy of this belief in a review of the article. During inspiration alone no equalization of pressure ordinarily occurs, but on deglutition equalization is restored. B.].

Hammerschlag, V., On the Reflex Movements of the Tensor Tympani and Its Central Paths. Sitzungber der Wien Akad, Math-naturn, Bd. CVIII., 3, p. 1. The contraction of the tensor in dogs, is believed by H. to be a reflex, passing through the auditory nerve and originating in sound waves. In addition to the tract between the eighth and the fifth nuclei of the same side there is one between the eighth nerve nucleus of the one and the fifth motor nucleus of the other. Contractions of the tensor tympani occur after removal of the entire brain cortex, hence is a pure reflex process.

Hartmann, A., Function der Tuba Eustachii. Archiv. f. Anat. und Physiologie, 1874. Experiments regarding the amount of pressure necessary to inject air through the tubes under varying conditions. While the muscles were in a state of rest air entered at a pressure of 20 to 40 mm. column of mercury. During the act of swallowing, 20 mm. or less was sufficient. In only one of the individuals who submitted himself to the experiments, the Eustachian tubes were open in a state of rest and the membrana tympani were pressed outward at a pressure of 10 mm. of mercury.

Hartmann, A., Mittheilung über die Function der Tuba Eustachii. Archiv. für Anatomie und Physiologie, 1877, pp. 543-548. H. concludes that the act of swallowing draws tense the membranous walls of the tube, transforming this previously flaccid canal into a rigid one, that the tube remains closed as long as the muscles of the soft palate are at rest. He states that the weight of 200 mm. of mercury by manometric measurement is incapable of causing air to enter the tube

while the muscles are uncontracted; and he believes that the membranous wall is but pressed the more firmly against the cartilaginous anterior wall of the tube; but that this valvular action is overcome by swallowing. From within the middle ear, air readily escapes from the pharyngeal orifice of the tube, as is proved by the escape of air bubbles when a person in the pneumatic cabinet is subjected to only slight rarefication of atmospheric pressure.

Hartmann, A., Experimentelle Studien ueber die Function der Eustachisen Röhre. Leipsic, 1879. H. states that great condensation of the air in the naso-pharynx opposes the opening of the tube, even during deglutition, by reason of the air pressure acting to force the membranous part of the tube against the cartilaginous roof. He proves that during respiration no interchange of air occurs between the tympanic cavity and pharynx in normal tubes. If abnormally patent there is an interchange, noticeable in a visible vibration of the Mt. coincident with respiration. Phonation may facilitate the passage of air but does not do it so completely as deglutition. He accepts Zaufals' view that the act of deglutition moves the medial cartilaginous plate of the tube backward and medially. Thus the floor of the mouth of the tube expands by the separation of the lateral walls from each other. Simultaneously the prominence of the levator advances toward the orifice of the tube which is thereby narrowed from above, downward, and from behind, forward. The sound-conducting power of the tube is but slightly discussed.

Hartmann, A., Uber die Bestimmung der Durchgängigkeit der Eustachischen Röhre mit Hülfe des Quicksilbermanometers, Virchow's Archives, Bd. LXXIV., 1878, pp. 420-424. A repetition of the views expressed in his monograph on same subject.

Haug, R., Foreign Body in the Tubal Region After a Previous Radical Operation: Tonsillar Abscess. Arch, f. Ohrenh., LVII., p. 45. A cotton pledget was lost in the depths of the auditory canal during the performance of a radical mastoid operation. An abscess of the peritonsillar tissue later appeared and on its evacuation the cotton pledget appeared. It was supposed to have reached its location through the levator muscle.

Heflebower, R. C., Clonic Spasm of the Tensor Tympani, N. Y. Med. Jour., LXI., 1895, pp. 325-328. A clicking noise ac-

companied by twitching of throat muscles was complained of. A perceptible indrawing of the central and lower part of Mt. was visible at time of each click.

Holinger, J., Spongyfying of the Labyrinth. Laryngoscope, XI., 1901, pp. 31-35. An attempt is made by H. to differentiate between the diseases named and Eustachian obstruction. In Eustachian obstruction he gives predominant symptoms as: (a.) Retraction of the Mt., often extreme. (b.) Nose is affected by hypertrophies and subject to frequent colds. Pharynx is always examined with mirror and palate hook. (c.) Hearing distance increases after catheterization. Smokers' catarrh and stomach disorders affect the disease. In spongification of the labyrinth we have: (a.) usually a history of deafness in family. (b.) The onset rarely begins before the age of 18 to 24. (c.) Sudden increase of deafness with heavy cannon shot noises. (d.) Mt. normal or nearly so. Nose, normal as a rule. Finally in the latter we have negative Rinné test, increased bone conduction for the lower sounds and a defect in hearing ability, mostly at the lower limits of the normal range.

Hopkins, Agnes, On the Relative Dimensions of the Osseous Semicircular Canals of Birds. Biological Bulletin, Vol. XI., 1906, pp. 253-263. "The Eustachian tubes of birds have a common oesophageal opening in all cases, except in the genera Struthio, Eudytes, and Tinamus where there is a pair of apertures. The Eustachian tube is a perfect bony tube in the following: Sterna, Squatarola, Ceryle, Psittacus, Geococcyx, Tetraonidae, Phasianidae, Catharista, Falco, Eudytes and Tinamus. In all other cases it is imperfectly ossified."

Hopkins, Frank T., Electrolysis in the Treatment of Chronic Eustachian Stenosis. Archives of Otology, XXXIV., 1905, pp. 495-501. H. begins with a No. 1 bougie (French) and at intervals of from two to four weeks, repeated until at the expiration of several months the next size may be easily introduced. In the same way proceed to the use of Nos. 3 and 4 or even 5. Between the times of using the bougies, inflation with vapor or air is used. In the discussion (ibid. pp. 539-546) members gave varying opinions regarding the usefulness of the electric bougie. Some had found the bone bougie equally good or better than the electrolysis. Several cases in which the tip of the gold bougie had broken off in the tube, where they still remained, without the patient being apparently worse than before, were reported.

Hovell, T. Mark, Catheterization of the Eustachian Tube. Brit. Med. Jour., Oct. 22, 1898, p. 1238. The author here proposes (1) that the gauge of the Eustachian catheter be that of the French catheter gauge; (2) that the length of the curve of the instrument be expressed in millimeters, the number indicating the distance the curve separates two parallel lines.

Hovell, T. Mark, Catheterization of the Eustachian Tubes. Archives of Otol. XXVIII., 1899, pp. 51-52. The need of a uniformity of scale in the measurements of Eustachian catheter is stated.

Hubbard, Thomas, An Apparatus of Precision for Inflating and Medicating the Tympanum. Archives of Otol., XXII., 1893, pp. 27-32. An instrument is described by which sterile air is used for politzeration or inflation of the Eustachian tubes.

Jacobi, A., Otitis Media in Children. Arch. of Otol., XXXIV., 1905, pp. 90-101. Pyogenic microbes enter the middle ear chiefly by way of the Eustachian tube which R. O. Newman finds, even normally, contains microbes. They enter especially when coughing, sneezing or vomiting. Mainly so when the nares are obstructed by swelling, by a membrane or by congenital occlusion. The vibrating epithelia of the tube become paralyzed in conditions of ill-nutrition, colds and atrophy. In the young, the Eustachian tube is shorter but wider both at the isthmus and at the tympanic orifice and the direction of the canal is almost horizontal.

Joachim, Otto, Contribution to the Physiology of the Soft Palate Archives of Otology, XVIII., 1889, pp. 226-234. The entire nose was destroyed by syphilis in a case of the writer's, giving easy view of the entire pharynx and mouths of the Eustachian tubes. The orifice of the left tube was impervious and occluded with a considerably reduced power of hearing on this side. The effect of various articulated sounds on the motions of the soft palate and Eustachian orifice was carefully studied by the author.

Kayser, R., Contribution to the Pathology and Treatment of Objective Ear Noises which, according to their Mode of Development, are divided into Tubal and Real Ear Noises. Trans. German Otol. Soc., 4th meeting, 1895. Arch. of Otol., XXIV., 1895, pp. 328-329. "The tubal noises are either

Buck, A. H., Unnatural Patency of the Eustachian Tube. Am. Jour. of Otology, II., 1880, pp. 203-205. A case related.

Bürkner, Report on the Treatment of Affections of the Tube. Report German Otol. Soc., 3rd meeting. Arch. of Otology, XXIV., 1895, pp. 59-62. Attention is called to the importance of catheterization when there is swelling in and mucous secretion of the tube, preferring it to Politzerization. The fear of causing infection of the middle ear in acute naso-pharyngeal or tubal affections is an exaggerated one, the neglect to inflate the middle ear causing the most harm. Gargling is regarded as an important measure in all simple tubal affections. Injections through the catheter are useful but should not be irritating. The use of the bougie in the tube is only indicated when catheterization causes no improvement. Medications and the use of the bougie are seldom productive of good results, though the vibration massage, by means of the bougie, by Urbantschitsch's method, is sometimes indicated. This is often painful. Politzer's method of external massage, on the other hand, is not. In atresia of the tube electrolysis and excision of the drum membrane and malleus are measures for consideration. Abnormal patulousness of the tube and abnormal conditions of the nose and naso-pharynx (ulcerative processes, synechiae, adenoid vegetations and hypertrophy of the tube) are important in their bearing. Galvano-cautery is not devoid of danger; acids are preferable. Discussion: Bezold agrees that the air douche should be used in acute affections of the tube. Catheterization is often preferable to Politzerization even in children. He has never found atresia of the tube in all his autopsies. The use of the bougie should be restricted. Bresgen recommends removal of nasal obstructions. Siebenmann does not consider nasal obstruction to have any etiologic significance in tubal disease. Apart from adenoids he has not found stenosis at autopsies. Barth and Fischenick believe nasal obstruction an etiological factor. Hartmann uses inflation as long as good results are obtained. He frequently uses injections. Cocaine acts well. Removal of nasal tumor may often be dispensed with if thin, short-beaked catheters are used.

Calhoun, A. W., Adenoid Vegetations, with Especial Reference to Their Influence Upon the Ear. Laryngoscope, VI., 1899, pp. 164-168. "Direct pressure upon the mouth of the tube rarely occurs, and yet its function is so frequently inter-

fered with that contraction or sinking of the drum-head follows. Perhaps the aural symptoms are due to the swelling of the mouth of the tube or an extension of the inflammatory process through the tube into the middle ear. Breathing through the mouth and the blocking of the post-nasal space change the air currents and alter the pressure about the mouth of the tube." The growth hinders the free action of the muscles controlling the lumen of the tube and permitting the entrance of air into the middle ear. This condition causes defects of hearing. This process sooner or later ends in chronic catarrhal otitis media with ankylosis of the ossicles. A suppurative inflammation frequently results from the presence of the mass.

Camerer, Foreign Body in the Eustachian Tube. Archiv. für Ohrenheilk, XL., 1896, pp. 63-64; Tubingen, 1894, Abs. A six-year-old boy fell from a wagon fifteen months previously. A piece of straw was driven into the mouth at that time but the visible portion was removed. One month later the right lateral pharyngeal region presented a swollen condition and otorrhea appeared in right ear. The latter continued a year with latterly aural hemorrhage. On the removal of offensive pus and granulations, roughened bone was detected and a movable body, which when removed proved to be a straw, 4½ cm. by 2 mm.

Citelli, S., On the Structure of the Human Eustachian Tube. Archivio italiano di otologia, XVI., 1905, pp. 404-418, pp. 441-452. The histology of the tube is given in detail.

Collet, On Salpingoscopy. Lyon Médical, 46, 1903, pp. 725-730. The Valentin Salpingoscope is recommended.

Dench, E. B., New Eustachian Bougie. Archives of Otology, XXI., 1892, pp. 149-156. A fine whalebone bougie is used. This is attached to the catheter by guides so that the lumen of the tube is not obstructed; at the same time the bougie may be passed into the tube at the same introduction as the catheter.

Denker, The Eustachian Tube of the Ant-Eater. Zeitschr. für Morphologie u. Antropologie, Bd. VIII., pp. 1-10. A paper regarding the comparative anatomy of Myrmecophaga jubata and M. didactyla.

Denker, Investigations of the Eustachian Tube of the Ant-Eater. Myrmecophaga, didactyla st M. jubata. Trans. Ger. Otol. Soc., 1904. In the first, no true tube exists, for a broad cavity surrounded by membranous walls occupies the place

of the tube. No bony tube. There is a round opening from the posterior and inferior corner of the tympanum to which the membranous canal is attached. In the latter species the large cavity is surrounded anteriorily by the tympanum and the pterygoid, posteriorily by a process of the basilar occipital.

Dennert, H., Zur Physiologie der Tuba Eustachii Grund einer Beobachtung von doppeleitigen organischen Verschluss der Raschenmendung derselben. Deutsche Zeitschrift für Pract. Medicin, No. 44, 1878. D. observed a patient with great syphilitic destruction of the naso-pharyngeal space. Cicatrix closed off the mouths of the Eustachian tube. Hearing was impaired and tinnitus present. During the act of swallowing both (most in left) Mt. were observed to sink in with subsequent outward motion. The same was observed when the nose was held during deglutition. D. thinks the phenomena due to a dilitation of the tube in the act of swallowing, producing a rarefication of the enclosed air.

De Rossi, Researches on the Micro-organisms in the Eustachian Tube of Healthy Individuals. Trans. 9th Internat. Med. Cong., pp. 859-862, 1887, Washington. In the secretions of the Eustachian tubes of twelve healthy individuals examined, the presence of germs was determined in six. None were of a pathologic character.

De Simoni, A., Intratympanic Injections in the Treatment of Chronic Middle Ear Catarrh. Arch. ital. di otologia, VII., p. 81. States good results followed use of vaseline oil and iodoform-ether through Eustachian tubes.

Duel, Arthur B., The Possibilities and Limitations of the Electroyltic Bougie in the Treatment of Chronic Catarrhal Otitis. Laryngoscope, XIII., 1903, pp. 523-532. D. thinks this method pre-eminent as a method of restoring patency of the tube. Best results are obtained by employing it sparingly and in connection with other forms of treatment. Intervals of two weeks should elapse before repetition. Caution is advised against using too often, too strong, and too hurriedly. Small bougies, small current, time and patience are advised.

Duel, A. B., The Rapid Dilation of the Eustachian Tube by Electrolysis. Laryngoscope, III., 1897, pp. 31-37. The electrolytic action of the negative pole of the galvanic current is employed. It is applied by one of four copper bougies, Nos. 3 to 6 French, mounted on No. 5 piano wire. They are passed through insulated silver catheters.

Duel, A. B., An Additional Note on the Treatment of Strictures of the Eustachian Tube by Electrolysis. Laryngoscope. IV., 1898, pp. 116-119. D. repeats that this treatment is not recommended for sclerosis but only for narrowing of the tube. 20 to 40 volts are required of 2 to 5 amperes. The operator should satisfy himself that the catheter is in place by the rhinoscopic mirror, or by successful inflation before the introduction of the gold bougie. The silver catheter is insulated by rubber dressing. The bougie should be pushed past the constriction slowly, occupying two minutes or more. The bougieing should not be repeated before a week or more but inflations should be continued. Many cases seem to be cured by one bougieing.

Duel, A. B., The Value of Electrolytic Dilitation of the Eustachian Tubes in Chronic Tubal Catarrh and Chronic Otitis Media. Amer. Jour. Med. Sciences, April, 1900. Many of the 50 reported cases were relieved or much improved as to the vertigo and tinnitus by restoration of the patency of the tubes. In nearly one-half the impairment of hearing was improved. The bougies are made of solid gold 2, 3 and 4 French scale. They should fit the tube snugly. The bougie is attached to the negative pole; the positive pole held in the patient's hand. Obstructions in the tube are overcome by using from 1 to 3 amperes of the current. After 20 seconds the bougie may be further introduced. It is not employed for more than five minutes at one time, and repeated at intervals of one week to one month, inflations being practised every other day. Two to four sittings are usually sufficient. A battery of 30 to 50 volts is employed.

Eitelberg, von A., Bougieing the Eustachian Tube. Tr. by Dr. Cornelius Williams. Archives of Otology, XIII., 1884, pp. 168-182. E. ascertained the average length of the Eustachian tube in adults as 36 to 44 mm. In the newly born the average is 19 mm. E. found that the penetration of the catheter amounted to from 6 to 11 mm. The longest tube measured among 15 fresh specimens was 48 mm.; the isthmus tubæ in this case was 28 mm. from the tubal orifice (pharyngeal end). The average distance from the ostium pharyngeum to the isthmus is 24 mm. The normal width of the isthmus is 1½ to 2 mm. In a case of chronic suppuration a bougie of large size (No. 4 Charrière) freely entered both tubes and could be made to

Ménière, E., On the use of Rubber Bougies in Chronic Catarrhal Affections of the Eustachian Tube and the Tympanum. Moscow International Conference, Arch. of Otol. XXVII., 1898, pp. 97, 98. "Chronic inflammation of the Eustachian tube is the most frequent cause of gradually progressive loss of hearing. In these cases, repeated insufflations of air often have no effect, though sometimes a marked improvement is produced by passing the bougies. The elastic bougies are the only serviceable ones; the end must be conical, and pass through a catheter of 1½—2 mm. breadth. The following solution is used: Iodine pur, iodide of potash, each one grain, distilled water 13 grains. The bougie may remain in position 1 to 60 minutes. Irritation is slight; occasionally burning in the naso-pharynx will be complained of."

Miot, C. Reflection sur l'obstruction de la trompe chez un diabetique. Remarks on the Obstruction of the Eustachian Tube in a Diabetic Patient. Société franc, d'otologie, April 15, 1887. M. states that cases of ear trouble in diabeties are caused by swelling of the Eustachian tube. They vary in deviation and intensity. Some are curable, in others the tube is permanently obstructed. M. believes the constant current allays the congestion of the tube and renders possible the introduction of bougies (and the application of the galvanic cautery.)

Michel, C. Neue Beobachtung über des Verhalten der Rachenmündung der Tuba und über die Thätigkeit der Muskulatur des Schlundkopfes. Berliner Klin. Wochensch., 1875, pp. 558-561. A patient, 20 years old, lost the entire nasal septum permitting direct observation. On swallowing, the posterior surface of the soft palate came into view pressing laterally between the cartilaginous projections of the Eustachian tubes and rising convexly against the posterior pharyngeal wall. Simultaneously the projections of the cartilages were elevated, their lower border approaching the median space of the pharynx; while, behind them, on the posterior pharyngeal wall appeared two projections rising from 1 to 1¼ cm. above the surface of the palate and having a smooth surface 1 cm. wide between. On forcible deglution this intermediate space disappeared and the mucous membrane presented additional folds. During phonation the appearance was much the same, except that a thick fold appeared on either side at the junction of the posterior and lateral pharyngeal walls. On sounding the vowel a, the palate was nearly flat; with e, i, o, u, it rose considerably above this

level. The anterior border of the Eustachian opening remained nearly motionless, except that below it there appeared a slight fold which was lost in the border of the palate, moving backward and forward during the act of swallowing. When at rest the Eustachian opening appeared like a furrow, the lower portion of which formed a triangle, the walls above lying in contact. The act of swallowing was accompanied by a wave-like motion on the floor of the orifice, then an elevation, the floor of the tube rising into the opening; and at the height of the act, the moment of greatest elevation of the floor, the furrow opened, presenting the appearance of a dark triangle, the apex of which was lost in a black line extending upward. During phonation the cartilaginous projection of the tube moves backward, and its lower border is elevated by the upward pressure of the floor. The orifice opens only during the singing of the high i or e, as with these vowels the palate is forcibly elevated and the floor of the Eustachian opening pressed upward. On sounding these vowels both the cartilage projection and the velum vibrate forcibly, and the transmission of these vibrations to the osseous portion of the tube and to the ear may explain in great measure the singing sound heard on sounding and holding the high i. The cracking sound heard on swallowing may also be explained by the movement of the cartilage of the tube. [This conclusion I believe is erroneous. It is caused by the drawing apart of the lips of the mouth of the tube].

Molinie, J., Defect of the Lips of the Eustachian Tube and Atresia of the Pharyngeal Tubal Ostium. Report of Trans. 7th Int. Otol. Cong. in Arch. of Otol., XXXIV., 1905, p. 327 (Also in Bull. de laryngol., otol. et rhinol., VII., 1904, p. 187). M. saw 2 cases of contraction of the naso-pharyngeal isthmus with atresia of tube. Both cases he thought due to too energetic use of galvano-caustic applications.

Moos, S., Klinik der Ohrenkrankheiten, Wien 1866. The folds in the lining mucous membrane of the Eustachian tube are most numerous at its lower portion and form a bulging just behind the pharyngeal orifice which aid in the closing of the tube.

Moos, S., A Preliminary Notice on the Anatomy and Physiology of the Eustachian Tube. Arch. Ophthal. and Otol., I., 1869, pp. 716-717. Believes tube is closed while at rest by an intumescense at the pharyngeal orifice.

Moos, S., The Histological Changes of the Eustachian Tube in Chronic Catarrh. (Trans. by Dr. A. N. Blodgett.) Arch. Ophthal. and Otol., V., 1876, pp. 542-560, pll. I. and II. A case treated for Eustachian tube stenosis, at intervals for 10 years, came to autopsy. Normal and pathological anatomy of the tubes described.

Moos, S., Beitrage zur Normalen und Pathologischen Anatomie und zur Physiologie der Eustachischen Röhre. Weisbaden, 1874, p. 53, pl. VI. The tube when at rest is closed at a point just behind the funnel-shaped end of the faucial opening and this closure extends through about two-fifths of the length of the canal. On the lower surface, or floor, of the tube the closure is effected by the longitudinal folds of mucous membrane which form a considerable prominence, really a valve of variable size. On the opposite surface of the canal, below the cartilaginous hook, in the lower portion of the canal, is another prominence of mucous membrane smaller than the other. These have their analogy in the lower animals. They probably facilitate the patescence of the canal by their unrolling. The cartilaginous "islands" of the tube are divided into five classes, the most important being those on the floor and sides of the tube. Those on the sides consist always of fibro-cartilage. They assume here the function of sesamoid bones in the tubal mechanism through their attachments.

Myles, R. C., Adhesions Connecting the Eustachian Tube to the Pharyngeal Wall above. Arch. of Otol., XXVI., 1897, pp. 322-323. Two cases reported in which there were adhesions connecting the Eustachian tube to the walls of the pharynx, forming a number of cavities (recesses?). The adhesions were torn with the finger with relief of symptoms.

Nicoladoni, C., Beobachtung am Lebenden uber die Bewegung der Tuba Eustachii. Monatschr. für Ohrenheilk Aug., 1875. A favorable opportunity for observing the movements of the Eustachian tube was presented by the performance of an operation on a tumor of the naso-pharynx by first removing the upper jaw. "Simultaneously with the contact of the soft palate with the posterior pharyngeal wall, its posterior surface being almost in line with the floor of the nose the medial portion of the tube, about one millimetre in height, began its movement while the lateral portion appeared to remain at rest. The movement, rather rapidly performed, consisted in an elevation for about three millimetres of the lower prominent edge of the medial portion which appeared

to be also drawn backward and slightly toward the medium line. At the same time the lower boundary of the fossa of Rosenmüller became sharply marked and projected into the median space, an arcus salpingeus, the apex of the tube, remained at rest." A bubble formed of blood serum formed over the orifice of the tube. At each act of swallowing this bubble sank into the depth of the Eustachian tube to reappear immediately on the completion of the act.

Peter, The Eustachian Tubes and Their Appendages in the Mammalia. Arch. für Microscop. Anat. XLIII., 1894, pp. 327-376.

Pierce, Norval H., On the Value of Electrolysis in the Eustachian Tube. Arch. of Otol., XXXI., 1902, pp. 289-296. A good anatomical demonstration of the tube. The conclusions of the writer are that (1.) in otosclerotic disease electrolysis is useless; (2.) in the great majority of cases of catarrhal disease, it has no advantage over other methods of treatment; (3) in a certain few cases where there is probably a soft exudate near the isthmus, it may be regarded as of some value.

Randall, B. A., The Prime Effect upon the Ear of Nasal Stenosis. Phila. Polyclinic, IV., 1895, p. 173.

Randall, B. A., The Technic and Value of Catheter Inflation of the Tympanum. Phila. Polyclinic, VII., 1898, pp. 551-552. R. expresses confidence in its use.

Randall, B. A., Clinical Anatomy of the Eustachian Tube. Laryngoscope, IX., 1900, p. 82. There is little variation in the topography of the surrounding parts. The back edge of the hard palate is practically unvarying. The lumen of the tube is a slit, usually collapsed and devoid of its "safety tube" at its inner third, while a valvelike fold in its bifurcated lower part serves with the drag of the relaxed palate, to insure its closure.

Ranke, H., Case of Malformation of the Ear. Sitsungsber d. Ges. f. Morphol. und Physiol. in Munich, No. 2, 1889, p. 68. The case examined post-mortem revealed the meatus ending in a blind tube. The tympanic cavity was entirely absent. The Eustachian tube was rudimentary and ended blindly.

Reitmann, Karl, On the Structure of the Cartilage of the Eustachian Tube in Man. Monats. für Ohrenheilk, XXXVIII., 1903, pp. 45-50. The cartilage of the Eustachian tube of the new-born is a typical reticular cartilage. In the adult

the elastic fibres surround the cartilage cells. Occasionally there are vascular channels in the cartilage which generally carry veins. The fatty degeneration of the cartilage, occasionally appearing, is regarded by the author as responsible for the fragmentation of the tubal cartilage."

Roaldes, A. W. de, Otological Pecularities of the Negro. Rev. de Laryngol. et d' Otol., XV., 1895, pp. 1169-1182. Among other differences noted, the mouths of the E. tubes are stated to be larger, the naso-pharynx much more spacious, deaf-mutism rarer.

Roure, M., On the Passage of Bougies in the Tubes in Cases of Dry Middle Ear Catarrh. Bull. de laryngol., otol., et rhinol., VII., 1904, p. 250. Uses a steel bougie and a modified catheter.

Royet, Adhesions of the Eustachian Tube to the Posterior Pharyngeal Wall as a Cause for Progressive Sclerosing Otitis and Symptoms of Vertigo. Archiv. internat. de Laryngol., d' otol., et de Rhinol., XVII., 1904, p. 371-397. The cause of progressing deafness is assigned by R. to the broad adhesions of the pharyngeal opening of the Eustachian tube to the posterior pharyngeal wall. After division of these adhesions with the finger the author believes he has observed cases of recovery, improvement or at least a bar to its progress.

Rumbold, Thos. F., Functions of the Eustachian Tube. St. Louis Medical and Surgical Journal, July 20 to Sept. 5, 1880.

Rumbold, Thos. M., Remarks on the Inflation of the Middle Ear. Laryngoscope, II., 1897, pp. 291-294. R. believes two objects are accomplished by inflation with the Politzer bag: (1.) removal of a plug of mucus from the tube of the middle ear cavity; (2.) restoration of the normal atmospheric pressure of the middle ear.

Schade, Migration of a Nail from the Naso-pharynx into the Middle Ear. Deutsche Med. Wochenschr., XXVIII., 1902, p. 796. Four years previously the patient extracted a nail from a box with his teeth. He swallowed the nail and suffered pain in his throat for some time. Attempts at extraction failed. Lately after a violent motion sudden pain occurred in the left ear and in three days the patient was able to extract the nail out of the ear. It was 12 mm. long, 1 mm. thick and bent in the middle. [There seems to be no proof that the nail passed through the tube. B.].

Schwalbe, G., Text-book of the Anatomy of the Organs of Special Sense. 2nd part, 2nd half, Eslanger, 1886. Schwalbe agrees that the greater portion of the cartilaginous tube is closed in a state of rest. It represents a closed vertical fissure, which every now and then is opened either by the simultaneous action of the tensor and levator palati or by the tensor alone. The orifice may also be opened by the tensor alone, independently of the act of swallowing. The levator is (thus) presumed to act by virtue of the fact that the belly of the muscle is thickened, in the region of the tube, by its contraction and so the walls are pressed apart. Contraction of the muscular fibres of the posterior-superior portions of the tube alone does not enlarge the orifice of the tube; this rather elongates the vertical fissure, smooths out the folds on the m. m. of the floor and thus fixes that portion of the tube wall.

Schwabach, D., On the Pathological Anatomy of Deaf-mutism. Arch. of Otology, XXXII., 1903, p. 378. The case described was that of a deaf mute who died of acute miliary tuberculosis. The mucous membrane of the bony Eustachian tube was very much thickened and infiltrated with small round cells in the superficial parts and in the deeper parts in the neighborhood of the tympanum.

Schumacher, H., Wratsch Gaseta, No. 19, 1902, in a paper, Ear Disease in Abdominal Typhoid, states that ear complications from typhoid are more common in children; that infection reaches T. by the way of the blood and Eustachian tube, and that syringing of the naso-pharynx is to be avoided because of the liability of forcing the passage of secretions through Eustachian tube to T.

Schwartze, Gehör-organ, pp. 103-104. A luxuriant tubercular growth surrounding the pharyngeal recess (fossa of Rosenmüller) on one side was observed. The recess itself was converted into a craterlike excavation twice the depth of its fellow.

Siebenmann, F., On the First Appearance of the Auditory Ossicles and the Tubo-tympanic Space in Man. Report Proc. 3rd meeting German Otolg. Soc., 1894. Arch. of Otology, XXIV., 1895, p. 56. "Examination of human embryos of the 3rd to 6th, 8th week showed that the blastem of the cartilaginous capsule appears in the 4th week, that of the annulus stapedialis in the 5th and that of the malleus and incus in the 6th week. Even at the earliest stage the blastem of the annulus stapedialis lies near the labyrinth

muscular or elsewhere developed, as in autophonia, but transferred by changes to the tube. He considers the first form allied to chorea and hysteria, caused by contraction of the tensor veli palati. He uses for treatment an irritation by pressing either the velum palati, mastoid process or the teeth, but with varying success. If the snapping noise is produced by the separation of the tubal walls, a probe is introduced with immediate good results which persisted in but three cases." A discussion on the possibility of hearing the noises produced by the contraction of the tensor tympani arose but the views were discordant.

Kenefick, Joseph H., Electrolysis in the Destruction of Organized Strictures of the Eustachian Tube. Archives of Otology, XXX., 1901, pp. 73-84. K. concludes: (1) That it cannot be foretold in any given case just what result will follow this treatment, as this will depend largely on two comparatively unknown quantities, viz., (a.) the vascularity of the tube lining and its toleration of the electrical interference, and (b.) on the degree of tympanic involvement. (2) That tubal obstruction is present early in the great majority of cases of so-called chronic hypertrophic catarrhal otitis media and that their mechanical obstructions may be removed at an early stage of middle ear involvement with excellent results. (3) That the best means of reabsorption of an organized obstruction of the Eustachian tube is by the electrolytic bougie.

Kerrison, Philip D., Tinnitus Aurium. K. classifies the various sources of tinnitus as due to: (1) Conduction sounds. (2) Blood sounds. (3) Labyrinthine sounds—alteration of intralabyrinthine pressures. (4) Neurotic sounds—increased irritability of the nerve. (5) Cerebral sounds—lesions of the cerebral cortex.

Kirchner, W., On Formation of Diverticles in the Eustachian Tube, in Man. Pt. I. from "Festschrift für A. Koelliker, Leipsic, 1887. A specimen of an Eustachian tube was shown, presenting a diverticle, lined with thin, firm membrane. It was situated about 1.5 mm. from the pharyngeal opening, about the size and form of a small bean 7 mm. in diameter and 6 mm. deep and opening by a sinus into the E. tube. The tube itself was unchanged in length or diameter and the lining mucous membrane presented no considerable change. The author is unable to conclude whether the malformation was congenital or the result of morbid action.

Koenig, On Passing Bougies in the Tubes. Trans. Seventh Int. Otol. Congress in Arch. of Otol., XXXIV., 1905, p. 348. Uses a combination catheter and bougie, the latter introduced into a small channel which opens into the calibre of the catheter. With a simultaneous application of the air-douche, performed by the patient with a double bag, the introduction of the bougie is performed more easily. A different catheter is used for each side.

Kostanecki, Casimir von, The Pharyngeal Ostium of the Eustachian Tube and its Relation to the Naso-pharyngeal cavity. Arch. f. Mikrosc. Anat., XXIX., 1887, pp. 539-592, pll. II. Some abnormal cases are related. K. observes that the pharyngeal tonsil may extend to the tuberosity of the Eustachian tube and even into its ostium.

Kyle, D. Braden, The Position of the Orifice of the Eustachian Tube and the Possibility of Catheterizing it through the Mouth. Phil. Med. Journal, II., Sept. 24, 1898, pp. 622-626. A catheter for use through the mouth is made of coin silver, six inches in length and flexible. The patient depresses the tongue with a tongue depressor while the operator locates the tube with a mirror and introduces the catheter.

Kyle, J. J., Natural Gas and Eustachian Inflammation. Jour. A. M. A., XXX., 1898, pp. 658-659. Natural gas, containing a large proportion of sulphuretted hydrogen, is regarded as most irritating to the nasal and tubal membrane.

Lake, Richard, Abnormal Course of the Chorda Tympani Through the Tympanic Cavity. Lancet, Jan. 5, 1895, p. 28. Exit at usual level, ran horizontally forward to lowest ¼ of malleus handle, thence upwards passing through canal of Huguier and keeping below the tensor tympani.

Lancereau, Infection of Syphilis by Means of the Eustachian Catheter. Union Med., XLI., 1886, pp. 469-474.

Laryngoscope, The, Is the Eustachian tube open or closed during the Act of Deglutition? Laryngoscope, closed! Editorial Laryngoscope, III., 1897, p. 190-191—a comment on Dr. Stillson's paper.

Laval, Nasal Ausculsation of the Ear During Catheterization. Archiv. für Ohrenh., LXVI., 1901, p. 120. By means of a hearing tube introduced high up in the opposite nostril, during catheterization, differential diagnosis is aimed at between the sounds heard at (a.) the tubal ostrium, (b.) the tube,

sound of a vibrating tuning fork held in front of the nose during the act of swallowing is due to condensation of the air in the tube and ear and claiming that pressure of the tongue into the mouths of the tubes completely closing them, produces a similar effect.

Stirling, Alex. W., Itching of the Auditory Meatus. Laryngoscope, VIII., 1900, p. 146. S. thinks itching of the meatus of the ear is sometimes caused by irritation from inflammation or irritating applications at the pharyngeal end of the Eustachian tubes.

Tansley, J. Oscroft, A Piece of Bougie in the Eustachian Tube. Laryngoscope, XIII., 1903, pp. 36-40. A bulbous point of a bougie was found in the mouth of the tube where it had broken off. The method of treatment is also disapproved of by the author.

Thomson, St. Clair, Approximation of the Remains of Luschka's Tonsil and the Eustachian Cushions. Laryngoscope, IX., 1900, p. 58. T. believes "Sinuses in the vault of the naso-pharynx" were nothing but depressions produced, as the title of his communication describes, by the approximation of the remains of Luschka's tonsil and the Eustachian cushions.

Truckinbrod, C., A Malformation of the Ear. Archiv. of Otology, XIV., 1885, pp. 128-132, pl. II. In this case of marked deformity, there existed complete closure of auditory canal, middle ear very small, rudimentary ossicles. No trace of a drum membrane was found, solid bone being found in its situation. Eustachian tube was present. The tube had a large, quite uniform diameter throughout its length. Its vertical diameter at its opening into the tympanic cavity was 4 mm. Its length 2.4 cm., 1.4 cm. of which belongs to the bony tube. No isthmus tubae proper was found, its diameter at this situation was 2 mm. The tympanic cavity appeared as a considerable expansion of the extremity of the tube.

Uffenorde, W., The Auscultation of the Middle Ear. Arch. für Ohrenh., LXVI., 1902, p. 1. No diagnosis can be made by means of the distinctions of the sound, as to whether it is due to tubal or middle ear condition, as it may meet an obstruction which may absorb or reflect sound waves. (2.) The blowing noise comes from the end of the catheter and the tube, the middle ear acting as a resonator.

(3.) No conclusion as to the consistency of the secretion can be drawn from the musical character of the sound. (4.) Râles from the middle ear have a deeper note and a secondary sound due to the secretion falling backward. The tubal râles are higher and fewer. (5.) If no auscultation sound is heard in a moist catarrh, the obstruction is usually in the tube. (6.) Under ordinary conditions most of the secretion leaves the middle ear via the Eustachian tube. (7.) A whistling noise indicates secretion but gives no clue as to the size of perforation. In two cases the presence of crepitant râles during catheterization suggested the presence of an exudate in the middle ear. On incising the membrane no fluid was found. U. then investigated the subject of the generally accepted opinion regarding exudates of the tympanum. He used a fresh cadaver and disarticulated temporal bones. He finds it impossible to determine with the otoscope whether the sounds heard are near to, or far from, the ear of the observer. A vesicular murmur is produced principally at the end of the catheter and at the walls of the tube. The tympanum serves as a resonator. The musical character of the crepitant râle does not inform us as to the character of the secretion. Crepitant râles produced in the tympanum is regarded as due simply to changes in position of the secretion. This accounts for an unusual intensity of sound and by a musically lower note. The lower after-murmur is due to the secretions falling back into its former position. Tubal noises are higher and less intense corresponding to the smaller amount. The bursting of air bubbles can only explain a part of the secondary noises. If there is moist catarrh present and an auscultation murmur is perceived the obstruction is probably tubal [!] Conditions being favorable, removal of the discharge from the tympanum is probable of accomplishment through the tube into the epipharnyx. If the amount is small its evacuation is of importance. In the presence of a perforation, whistling murmur denotes secretion but it is not necessarily related to the size of the perforation. A perforation murmur may occur with an entire absence of the drum

Urbantschitsch, V., Bougieing the Eustachian Tubes in Chronic Disease of the Middle Ear, Especially in Chronic Middle Ear Catarrh. Wiener Med. Presse, Vol. 24, 1883, pp. 48-73. After chronic middle ear catarrh there often remains a narrowing

of the tube, especially at the isthmus, though the entrance of air is not much interfered with. He regularly uses bougies, on examination, in diagnosing O. M. C. C. employing the French bulbous bougies. He advocates the dilatation of all tubes in cases of impaired hearing and subjective noises in which a bougie 1⅓ mm. diameter cannot enter the bony portion or where it enters with great difficulty. Improvement takes place he believes by a reflex influence generated by the irritation of the sensitive twigs of the trigeminus, especially the tubal branches. This influence he thinks extends to all the senses and of course to the ear. He employs the bougies in chronic suppuration when associated with narrowing of the isthmus tubae.

Urbantschitsch, Ernst., Vibratory Massage of the Eustachian Tube in Chronic Middle Ear Catarrh. Monatsch. für Ohren., XXXVII., 1903, pp. 89-96. The thin celluloid bougie is introduced to the isthmus of the tube; then external massage is employed by means of a pad set in motion by a motor, and continued four minutes. U. thinks circulation is improved in tensor tympani and tubal muscles and in middle ear. He reports improvement of subjective noises.

Urbantschitsch, V., An Apparatus for Friction Massage of the Ear or Eustachian Tube. Monatsch. f. Ohren., XXXVI., 1902, pp. 455-467. An apparatus is constructed which has two electric magnets on a rod, arranged to convey various movements to the mucous membrane of the mouth of the tube and the naso-pharynx.

Vajda, V., Syphilitische Infection der Tuba Eustachii. Bericht der Klinik für Syphilis des K. K. Allgemeinen Krankenhauses, Wien, 1875. A case of syphilitic infection at the mouth of the tube from an infected Eustachian catheter.

Valentin, Ad., The Cystoscopic Examination of the Naso-pharynx or Salpingoscopy. Frankel's Arch. für Laryngol., XIII., 1903, pp. 410-420, Taf. XXII. The condition of the tubal ostium, upper wall of the naso-pharynx and the posterior surfaces of the velum are rendered visible by a cystoscope-like apparatus introduced through the nose.

Vali, On Objective Noises of the Ear. Arch. für Ohrenheilk., LXVI., 1906, p. 104. Objective noises usually develop from an abnormal circulation or tonic and clonic contractions of the muscles of the tympanum and in the pharynx. A case synchronous with pulse was not arrested by pressure on

the carotid but was stopped by depression of the tongue, by elevation of the soft palate and by catheterizing the tube. Regarded as due to clonic contractions of tensors and palate muscles.

Voltolini, R., Two Peculiar Ear Diseases. Monatschr. für Ohrenheilk, XVII., 1883, pp. 1-6. A twenty-year-old patient had for five years sensations of sudden valvelike closures of the ears lasting for some time. At these times, examination revealed a thin atrophic Mt., bulging outward and containing frothy mucus. By negative Valsalva the Mt. was made to withdraw against the inner T. wall. By slightly swallowing the first condition reappeared. Diagnosis: Dilatation of the Eustachian tube with exudation, confirmed by insertion of catgut bougies. Respiratory vibration of the Mt. was noted. On pronunciation of the letter R, a fluttering vibration was developed.

Voltolini, R., On the Catheterization of the Eustachian Tube in Cases of Palatal Fissure, and the Inspection of the Nasal Cavity from in front while it is being illumniated from behind. Monats. für Ohrenheilk., XVIII., 1884, pp. 7-8. In a patient with a cleft of both soft and hard palate, the posterior lip of the tube, but not its mouth, was visible through the oral cavity.

Warnecke, G., Simple and Vibratory Catheterization with a Current of Carbonic Acid Gas. Archiv. für Ohrenheilk., LXVIII., 1904, pp. 227-232. The gas is led by a tube to the catheter. The intermittent current is thought more active than the continuous.

White, F., Complete Deafness for Twenty-four Years from Eustachian Closure. Perfect recovery after a course of Politzeration. Brit. Med. Journal, March 2, 1895.

Wolf, Oscar, Review of Hartmann's "Experimentelle Studien ueber die Function der Eustachischen Röhre." Archives of Otology, VIII.,1879, pp. 209-211. He cites Hartmann's experiment showing that a slight pressure from within the middle ear only is necessary to overcome the closure of the tube, as a support to his theory that the Eustachian tube is protective by furnishing an outlet for sound waves. Loud sounds would, he thinks, produce grave changes in the ear without it.

Wolf, Oscar, Sprahe und Ohr., p. 240. W. states his experimental proof that the tube is for the outlet of sound—

a protective mechanism. It permits the sound waves to escape from the rigid walls of the osseous tympanum into the external air.

Yankauer, Sidney, Eustachian Sounds. Archives of Otology, XXXV., 1906, p. 247. The sounds described and here recommended by Y. are made of catgut surrounded by a resin. They bear sterilizing. They are not bulb-pointed. They are ringed near the proximal end for convenience in determining the distance introduced.

Zaufal, E., Die Plica Salpingopharyngea. Prague Med. Wochenschrift, Vol. IV., 1879, pp. 217-227. Calls this fold the ridge-fold. He observes that it projects forward in (swallowing) movements as a sharply defined medial fold of variable thickness. It extends 3—5 centimeters downward and backward as a direct continuation of the tubal convolution. When the head is bent backward it can be directly observed with the aid of an uvula retractor.

Zaufal, E., Die Plica Salpingopharyngea. Arch. für Ohrenheilk., Vol. XV., 1879-80, pp. 96-144. The various diseases affecting the fold are described. It is the seat of pronounced swelling and tumefaction. Cystoid follicles may develop in it which tend to obstruct the mouth of the tube.

Zuckerkandl, E., Zur Anatomie und Physiologie der Tuba Eustachiana. Monatsch. für Ohrenheilk., VII., 1873, pp. 125-145. Bundles of fibres, tendinous and elastic, pass from the pharyngeal end of the tube to connective tissue of the levator palati, the muscles of the pharynx and soft palate. These aid in drawing open and closing the orifice as different muscles are contracted.

Zuckerkandl, E., Anatomische Notiz über die Tuba Eustachiana eines Elephas Indicus. Monatschr. für Ohrenheilk., IX., 1875. There is no projection on the pharyngeal wall to mark the opening of the Eustachian tube in this animal, and it is discoverable only with some difficulty. It is almost exactly vertical. The ostium pharyngeam possesses no distinct cartilaginous boundary and appears as a small, irregular slit, the thick lateral wall longer than the membranous, median wall. The tubal cartilage is thicker above, assumes the form of an almost complete cylinder nearly surrounding the tube at its median portion. The tube is fixed to the skull by a comparatively slender basilar fibro-cartilage.

Zuckerkandl, E., Contributions to the Anatomy of the Organ of Hearing. Reviewed in Arch. of Otology, XIV., 1885, p. 211. On dissection, a small piece of bone, the size of a hemp seed, was found in the anterior wall of the Eustachian tube, the pharyngeal orifice being otherwise normal. The spicule was firmly adherent to the mucous membrane and Z. regards it as a circumscribed ossification of the cartilage. (Moos has published similar findings). Accessory cartilaginous plates in the floor of the Eustachian tube, in the pharyngeal prominences, the lateral walls, in the ligaments connecting the cartilaginous portion of the tube with the vault of the pharynx are so commonly found as to be considered normal.

Zuckerkandl, E., On the Eustachian Tube of the Ant-Eater. Monatsch. für Ohrenheilk, XXXVIII., 1904, pp. 1-7. Z. differs from the view of Hyrtl (1845) that the bony tube is absent in Myrmoscophaga jubata. Z. finds a bony tube 15 cm. long without any cartilaginous fundament attached to the margin of an opening in the temporal bone by which it communicates with the tympanum. Z. thinks Hyrtl mistook this opening for the carotid foramen.

Zuckerkandl, E., On the Anatomy of the Eustachian Tube. Monat. f. Ohrenheil., XL., 1906, pp. 1-11, etc. In these papers Z. gives results of his studies of the comparative anatomical characteristics of this region. The greatest differences are in the structures of the tubal walls, especially of the median walls. The lateral walls are approximately uniform, and usually fibrous. The median walls show varieties from fibrous to cartilaginous. In the lower forms of vertebrates the median walls are usually fibrous showing that the primitive tube was represented by a fibrous tube.

Zuckerkandl, E., A Contribution to the Comparative Anatomy of the Eustachian Tube. Arch. f. Ohrenheilk., XXXIII., 1886, pp. 201-213. The Eustachian tube of the Ornithorhynchus paradoxus or Duck-billed Platypus, is not tube-shaped but is represented by a simple fissure, which connects the tympanic cavity with the slightly pouched pharynx. All other mammals examined have a tube-shaped structure. This animal thus resembles in this structure the amphibia, the batrachia in general exhibiting a similar connection between the ear and the pharynx.

Zuckerkandl, E., The Eustachian Tube of the Tapir and Rhinoceros. Arch. f. Ohrenheilk., XXI., 1884, pp. 222-232. The Eustachian tubes of the tapir are remarkable by reason

of a smooth, narrow-edged air-sac, the size of a hen's egg, situated about 8 mm. behind the pharyngeal opening of the tube extending upwards 45 mm. connecting with the cartilaginous portion of the tube and reaching posteriorily 22 mm. beyond the auditory organ. The comparatively small amount of hyaline cartilage in the tube is placed at the superior wall, and projecting downward medially and laterally form here a sort of groove. The medial wall contains fibrous cartilage as support. The levator palati is pushed outward by the air-sac. The membranous lining of the tube presents numerous ridges, especially on its floor. It contained no acinous glands but adenoid tissue in the shape of follicles were found. The air-sacs resemble those found in the horse. The Eustachian tubes of the rhinoceros were found in the adult to be 89 mm. long. In the neighborhood of the junction with the bony tube a vascular network exists formed by arterial twigs from the internal carotid and distributed into the cavernous sinus. The hyaline cartilage has the typical shepherd's crook shape. The narrowest portion of the tube is near the middle of its length. Bundles of fibrous tissue containing some hyaline cartilage cells strengthened the cartilaginous tube. The mucous lining of the tube was paved with ciliabed epithelium; contained acinous glands in its deep layers and adenoid tissue superficially.

AUTO-TOXIC DEAFNESS.

By SARGENT F. SNOW, M. D., Syracuse, N. Y.

Undoubtedly each close observer of the deafness associated with a nonsuppurative catarrhal state, has been impressed by the fact, that there was some strong systemic causative factor in its development and it is to the consideration of this systemic factor that I would dedicate this paper.

Modern progress in Medical Science, both from clinical and laboratory research is showing positively that self poisoning (Auto-intoxication) is responsible for a great many of our bodily ailments. Be the affliction a simple cold or a grave infectious disease, the chances are that our natural anti-toxins would have protected us against bacterial invasion, had our glandular activity been up to a normal standard. The same principles for reasoning and treatment can be applied when we come to consider those insidious catarrhal states that lead to chronic deafness. While I don't like to force the discussion of Auto-intoxication upon this society, I will say to you that I personally believe there is no subject more worthy of attention, both by the specialist and the general practitioner.

In former papers, notably one on Systemic Factors in Catarrhal Deafness published March 23, 1901, and again one read before the International Otological Congress at Bordeaux in 1904, I have emphasized the influence that improper liver and bowel functions had, not realizing the strong Anti-toxic part, these organs, when active, and Auto-toxic when sluggish, could play in our economy, but further clinical observations have forced me to accept the conclusions which I shall now try to set forth in this paper.

Well selected nasal operative work has aided us materially in cutting short those inflammatory processes that start many on the road to Deafness.

An occluded nasal passage or a pressure on some sensitive nasal area, we know is apt to induce catarrhal states within the middle ear, but if that state is to progress to an advanced chronic deafness, some depressing organopathic influence must be at work, or the natural vital trend toward recovery will make the affliction but temporary.

In other words an abnormal nasal or pharyngeal state present in an Auto-intoxicated deaf patient whose skin is of a pale gray or a dirty color, whose tongue is coated posterally, whose breath is often foul, who has a constipated habit and shows other evidences of functional inactivity, is not one to clear up by simply attending to the abnormal nasal or pharyngeal state. In such a case without question, we will have to deal with their self-poisoning as well as with their intra-nasal pressures and pharyngeal obstructions.

Auto-intoxicated patients, male or female, present much the same general appearance. Accompanying their deafness there is a multiplicity of general disorders. They are prematurely aged, tongue bad, lips too red for the complexion. Skin sometimes spotted, conjunctiva often yellow. Appetite irregular and stools hard or mushy with a strong putrefective odor.

In these cases, an elimination of the accumulated entero-toxins must occur, and when this elimination is through the mucus membranes, it is characterized by congestions, which in the head at least, leads to the catarrhal activity and membrane thickenings so much noticed in the development of a chronic deafness.

In other words the elimination of entero-toxins through the nasal and aural mucosa, due perhaps to some predisposition, induces frequent inflammations. Auto-toxic energy exerted thus along a special course predisposes to catarrhal states within the deeper ear structures. In Auto-intoxicated cases, an elimination of accumulated enterotoxine by the different emunctories of the body must be fairly complete each day, or some acute crisis will be percipitated. Such an acute crisis may be a simple cold with fever, a diarrhoea, an erup-

tion, or a sick headache, and so on through a long list of neurotic and organic disturbances.

These acute Auto-toxic crisis are often periodic, as the enterotoxins tend to accumulate every one to two weeks in people who have an acquired or an inherited functional inactivity. A fact of much clinical and therapeutic importance*.

All Otological workers are balked in their efforts to improve the hearing, if the recurring congestions of the nasal membranes persist after the breath passages have been relieved of hypertrophies, deflections and sinus discharges. Recurring congestions of this sort are common in those cases of deafness that are to become or have already become extreme and chronic, and it is to the control of pernicious Auto-intoxications, that effort will have to be directed if we are to maintain our results from local work on impaired aural functions.

In handling these cases it seems well to at once take care of removable contributory causes within the respiratory passages, and acquaint ourselves with the Auto-toxic manifestations. The ideal and much to be preferred way, is to refer the patient to a specialist on Digestive Disorders for their constitutional troubles, but at present such specialists are rare and we send them to their busy family physician, often to find that they are not sick enough to command his interest and their Auto-intoxication continues. This is the reason we are sometimes forced to adopt other methods. Such cases impel the Aurist, reluctantly and in self defence to a closer study of systemic states, and he is justified in correcting diet, eliminating noxious material, from the bowels, and stimulating functional activity.

It is very easy for the ear and throat specialist to note the condition of the tongue, breath, skin and conjuctiva, and he will be impressed with the number of these patients who show a coated tongue, and who finally admit of irregular bowel habits.

Unfortunately people with digestive troubles are hard to

*See States' translation, of Prof. Combe's work on Auto-intoxication, Page 140 to 160.

manage and their deafness will prove intractable when once well started if we do not obtain sufficient influence over them to correct their diet and personal habits.

Those excellent Auto-toxic barriers, the Intestinal Mucosa and the Liver, if kept in an active healthy state, allow a good latitude as to what we can eat; but if these organs are incapacitated from being overtaxed or through an inherited tendency to weakness, our system has small chance of running the gauntlet without disaster. At least two bowel movements each day seems imperative.

For eliminative purposes, the author uses Mercury either in the form of Calomel triturated or a Blue Mass Compound, once or twice a week, according to the tongue and other indications. Calomel, we know, not only eliminates Auto-infective material, but it disinfects the lower bowel. It also stimulates functional activity of the glandular structures of the body, so that their secretions act as effective anti-toxins against bacterial invasion. Anticipating an Auto-toxis crisis by administering such an agent, saves our patient acute suffering and protects him from the ravages of chronic afflictions.

A diet regulated so as to diminish intestinal fermentation and putrefaction, is the all important effort. Fermentation of starch in the small intestine or putrefaction of Albuminoids in the large intestine is capable of exciting strong systemic disturbances. Carbohydrates often must be either substituted for, or freely mixed with nitrogenous elements. Putrefactive changes are markedly diminished by dry meals, hence we should not drink while eating, nor eat while drinking.

The generally acknowledged putrefactive ailments are the nitrogenous foods, and the Anti-putrefactive ailments are the lacto-farinaceous foods, and our local work on these Auto-intoxicated patients will be productive of good, according to how effective we are in their diet regulation.

As intimated, cases of Auto-toxic deafness are common, and according to the writer's opinion, comprise those in

which the determining factor is a toxaemia caused by vital processes of the body. Pardon my presumption if I say that this classification includes practically all the advanced so called chronic catarrhal cases.

I note that Dr. Cornet, at the French Congress of Laryngology, Otology and Rhinology, last year, expressed himself as of the opinion that the aetiology of Oto-sclerosis is Auto-intoxication, in the great majority of cases**.

In the treatment of Auto-toxic deafness much stress should be laid on the local efforts, as indicated earlier in this paper. The imperative necessity for a perfect, curved respiratory course through both nostrils, as pointed out by Pynchon*, so that the middle ear cavities and accessory sinuses are properly drained and ventilated, is not to be gainsaid. This in the majority of cases, calls for careful intra-nasal Surgery, and it is time and effort well spent.

The value of stimulating the membranes of the middle ear, by interrupted jets of camphor and Iodine vapor, from a super-saturated solution two or three times a week, for five minutes, at each setting is without question, if such routine be persistently carried out, after the Surgical and the Auto-toxic features of the case are out of the way. These last mentioned requirements are fixed and unalterable, but not unreasonable.

Laboratory investigations are showing great merit, but of equally great merit can be the clinical investigation of an observing thinking practitioner.

Two legitimate lines of effort appear to be open to Medical men, those qualified and equipped for laboratory work, may well continue their search for Serum Anti-toxins, while the general practitioner may well feel encouraged in his search for agents to wake up the glandular system of the body so that we manufacture our own Anti-toxins. Each of these lines of effort deserve the highest respect and commendation.

** See London Journal of Laryngology, Page 424 of 1908 and Page 9 of 1909.

*See "The Laryngoscope" July 1903.

There is still much to be learned, regarding the proper and best stimulants for arousing the anti-toxine producing elements of the body, but the author has a well fixed belief that many people when born have an impaired functional activity, and that they will have to be guided and guarded in a direct ratio with that impairment. These are the people most prone to chronic Aural troubles.

The past ten years of clinical observation in my most intractable cases of deafness has proved, that to retain, and make permanent the results obtained from our local work, we must correct systemic faults and that self-poisoning is the chief predetermining cause in our worst cases, hence the term chosen in title, Auto-toxic Deafness. In other words, that back of those catarrhal states that lead to extreme deafness, we have Auto-intoxication.

NASAL AND AURAL DISCHARGE IN CHILDREN.*

By PERCY FRIDENBERG, M. D., New York, N. Y.

The relation of naso-pharyngeal anomalies to various forms of deafness is becoming more and more the study not only of the rhinologist and otologist, but of the specialist in pediatrics, the family doctor, and the teacher, as well. The intractability of certain forms of dry, adhesive, or sclerosing middle ear catarrh, as the fairly uniform and definite type is variously called in ignorance of its actual pathology, and the hopelessness of purely aural treatment have led to more careful consideration of the factors supplied by the ventilation apparatus of the middle ear, the Eustachian tube, especially its pharyngeal ostium and the structures, pathological as well as physiological, in the post-nares. It is still an open question whether minor variations in the location or consistency of small lymphoid collections can produce far-reaching changes in the muscular apparatus of the tympanic cavity and in the articulations of the ossicular chain, as has been claimed. The results of treatment of the post-nasal anomaly have apparently been encouraging in some cases, but in the great majority the marked local changes so characteristic of old hyperplastic otitis media, the adhesions, atrophies and thickenings, the ankyloses and degenerations, have, as might have been expected, remained entirely uninfluenced by the minor surgical procedures aimed at post-nasal irregularities.

Quite a different picture is presented by the exudative forms of middle ear disease whether catarrhal, muco-purulent or frankly suppurative, in which the causal relation of naso-pharyngeal infection has come to be recognized as most important. The removal of adenoids as a step in the

* Read by title.

prophylaxis of otitis media and in the preservation of hearing, as well as in the treatment of persistent aural discharge is advocated as a routine measure and its benefits recognized even by the laity. There is another aspect of this question, however, which it seems to me, has not been fully considered, namely, the dependence of persistent low grade aural discharge of a muco-purulent character, upon nasal and naso-pharyngeal catarrh. This form of middle ear catarrh, which I have designated as "propagated" in a previous communication*, is not apt to cause bone involvement or to be complicated by mastoid invasion, so that it is not fraught with serious danger for the patient. It is, however, of practical importance on account of its frequency in children, its tendency to chronicity and relapse, and the possibility of its being mistaken for a type generally progressive and requiring operation, and its prompt relief and generally speedy cure by measures directed to the focus of mucus production in the post-nares or nose. Less has been written about this form of middle ear catarrh than on the type dependent on or associated with adenoid hypertrophy and characterized by acute inflammatory symptoms, pain, and generally purulent discharge from the ear.

The propagated or transmitted form depends primarily on a morbid accumulation or production of mucus or muco-pus in the naso-pharynx, and possibly in the Eustachian tube, and its discharge from the middle ear by an almost invariably spontaneous perforation of the tympanic membrane. In children, this type frequently appears as an acute catarrh tending to diminish or for a time to cease entirely under conditions, particularly climatic changes, favorable to a diminution or cessation of the secretion in the posterior nares, recurring with every cold in the head as well as with any affection of the respiratory tract or with acute infectious diseases, and occasionally "coming back" again without any evident nasal discharge, at least for the first few days. In these cases, examination of the naso-pharynx may fail to

*Archives of Pediatrics, November, 1908.

reveal any focus of inflammation or increased production of mucus, and I believe that we then have to deal with a purely tubal focus of reinfection. The tendency to recurrence causes an apparent chronicity with more or less extended intervals of what seems to be a cure. The latter factor is responsible for its appearance seemingly *de novo* in adults affected with post-nasal muco-pus accumulations. The persistence of the aural discharge in such cases may be complicated by chemical changes due to stagnation, which gives it the fetid qualities of old purulent otitis and is occasionally the cause of its being mistaken for and surgically treated as the latter type, although there is no bone involvement, except under very unusual conditions, to be mentioned later. The clinical features are strikingly uniform. The first symptom is often the appearance of a stringy, mucoid or slightly muco-purulent discharge, frequently bilateral, after a variable period of snuffles, with little or no systemic disturbance, slight fever if any, and no pain. In badly nourished children of the poorer classes this condition is very common. In the children's wards of Mt. Sinai Hospital, where through the kindness of Dr. Koplik, I have had the opportunity of making a series of routine examinations of the noses, throats, and ears, "otitis propagata" from nasal discharge is found in a large proportion of cases. Of late, I have found the examination of the post-nares greatly facilitated by the use of the Hays pharyngoscope, allowing direct inspection of larynx and epipharynx without a mirror and with the minimum of disturbance. In very small children it is somewhat difficult to get a clear view of the parts on account of gagging, but I have found that if we insert the pharyngoscope while the child is crying we can get an excellent survey. Aural examination generally shows a large perforation with a pale membrane, or at least no inflammatory reddening, and no canal changes at all. The benign character of the process is indicated by the absence of all bone involvement and of mastoid complication, and of marked local or constitutional reaction. There seems to be little tendency to reactive

processes of repair, too, as shown by the fact that the perforation rarely heals up except in those cases in which active treatment directed toward the post-nares has been instituted at an early stage. This is probably due, in no small measure to the recurrences, whereas the subsidence or cure of acute otitis purulent, unless it has run a protracted course or has been of the virulent type seen in scarlet fever, is usually followed by closure of the perforation in the tympanic membrane. The absence of pain may also be due in part to the favorable conditions of drainage afforded by this permanent opening, although I am inclined to believe that the melting away of the drum membrane without inflammatory reaction, dependent on the low grade infectiousness of the mucoid accumulation, explains this feature perfectly.

Irrigation of the middle ear with the usual mild solutions of bichloride or boracic acid, appears to bring about a cure, but the discharge recurs with the slightest disturbance of secretion in the post-nares. Astringent solutions, particularly zinc sulphate, 1—2%, have a more lasting effect, but a cure is rarely effected by purely local treatment. I have used suction evacuation with good effect for a time. If the source of the discharge is attacked directly by applications to the naso-pharynx or, if necessary, by removal of hypertrophic tissues, and subsequent treatment of their original site with nitrate of silver, 10-25%, resorcin-alcohol, 50%, or iodine-glycerine, 25%, the aural discharge is promptly cut short and recurrence effectually prevented in the great majority of cases. In some cases there is marked impairment of hearing, even during the periods of partial or complete freedom from aural discharge, and these cases are particularly amenable to the beneficial effects of treatment of the naso-pharynx. Reference has been made to the confounding of these cases with chronic purulent otitis media and the diagnosis may be obscured by two factors; pain, which is rare in uncomplicated cases, and fetid discharge, both of which are due to lack of free drainage and secondary infection, and the latter, to lack of cleanliness as well.

Secondary infection from the external auditory canal may change the secretion to a frankly purulent discharge and a true otitis with danger of bone involvement or mastoid complication may be engrafted on the original comparatively benign affection; an added reason for early removal of adenoid hypertrophies and for appropriate local treatment.

During the last few years I have observed a large number of these cases and in some of them pain in the ear, headache with occasional dizziness, diminished hearing and an old fetid discharge from the ear had suggested to competent otologists the advisability of a radical mastoid operation. It is by no means my intention to belittle the life-saving qualities of this valuable surgical procedure, or to suggest that it is not necessary in many cases, but the category of cases which I have described, and of which I see a large number during the late winter and early spring months, mostly in young children, should be more promptly, generally and thoroughly treated by the conservative and quite effectual means which I have indicated, viz., removal of the source of infection in the posterior nares or accessory sinuses by appropriate procedures, whether medicinal or operative.

PRESENTATION OF A SPECIMEN, (SEQUESTRUM OF ENTIRE LABYRINTH), WITH REPORT OF A CASE.

By JAMES F. McKERNON, M. D., New York, N. Y.

My object in presenting this specimen to the Society is not alone on account of its large size, but also on account of the after treatment of the case; a similar treatment being pursued in three other cases, all terminating successfully.

The history of the case from which this specimen was removed is, briefly, as follows: F. F., male, Italian, aged four years and three months, was admitted to my service in the "Babies' Ward" of the New York Post-Graduate Hospital, on December 12, 1908. The history given was, that the child had had a discharge from the ear for the past four years following an attack of measles. Three weeks before applying to the hospital for treatment the mother had noticed that the child's face was twisted, and that the mouth was drawn toward the opposite side, the child being unable to close his left eye. The patient had been very restless, had a high fever and was unable to sleep at night for any considerable length of time.

Physical examination showed a child well developed for the age given. He was, however, somewhat thin and emaciated; the tongue was dry and covered with a white coating and the skin was of a yellowish septic tint. There was complete facial paralysis on the left side and a free discharge of pus from the eye of the affected side.

Aural Examination: There was a thick greenish foul smelling discharge, which completely filled up the external auditory canal. Upon removing this, there was found a general thickening and induration of the canal walls, sufficient to prevent inspection of any portion of the drum membrane. A probe passed between the thickened walls

into the region of the middle ear came in contact with necrotic bone.

The temperature was 101.4°F. Pulse 124.

There was no external evidence of any mastoid involvement, either by inspection or by pressure. The child was dull, restless and apathetic, and would relapse into a semi-comatose state when undisturbed. The pupils were unchanged, the one on the opposite side from the affection being perhaps the larger. The eyes were examined and pronounced negative, except for the external inflammation of the left caused by the facial paralysis. The urine contained a trace of albumin.

As the child was admitted late in the evening, the operation was postponed until the next day, and a differential blood count ordered. At twelve o'clock that night the temperature rose to 104.5°F. and the child's condition changed from that of semi-coma to extreme restlessness, with almost constant moaning or crying. When seen the next morning the temperature had declined to 99.2°F., and the child had resumed his former semi-comatose state. The patient was prepared for operation, chloroform administered, the mastoid opened and found extensively involved. There was but little free pus, but two large cholesteatomatous masses were exposed, one occupying the antrum and the other in the region of the middle zygomatic root. The complete mastoid operation was done. There was a large dural exposure of the sinus from above the knee down to the bulb region, and a second extensive exposure in the region of the middle fossa. The posterior canal wall was then removed and a complete Schwartz-Stacke operation done. The middle ear was filled with a cholesteatomatous mass, and upon cleaning out all of the debris, the entire labyrinth was found to be loosened. This was removed, as shown here, in its entirety, save here and there, where a small portion of the bone had sloughed away during the necrotic invasion. Its removal left two more dural exposures, one the cerebellum posteriorly and the other, the

cerebrum superiorly. A modified "Pansa" flap of the tissue in the canal was made, but the posterior mastoid wound was not closed as it seemed wiser to leave it open for inspection and await developments. Smears were taken from both mastoid and middle ear, and aside from the cholesteatoma, a mixed infection was found.

A perusal of the accompanying temperature chart, which is abbreviated, will show the future course of the case better than an elaborate history can do. For six days after the operation the child remained unconscious, vomiting at intervals, and was kept alive by rectal nourishment. On the fifth day, thinking we might have a thrombosis to deal with, the sinus was opened with negative result. The same evening a lumbar puncture was done and 38 C. C. of turbid fluid were drawn and in four hours the child regained consciousness, and took nourishment by mouth. The fluid contained large number of meningo-cocci, and pus. During the next five days lumbar punctures were done each day. The entire quantity of fluid removed being 76 C. C., making in all, 114 C. C. On the sixth day, about only 4 C. C. came away when the puncture was made, and little, if any, relief was observed in the patient's condition. The relief for the first four days after each puncture and withdrawal of fluid was marked. Towards the latter part of each day he would lapse into his former state of coma, which would continue until some three to five hours after the fluid was withdrawn. Meeting with such meagre results from the last lumbar puncture, I determined to do a sub-arachnoid drainage. Two drains composed of chromatized gut, four strands each, wound with cargile membrane were introduced (without anaesthesia) into the sub-arachnoid space, one below where the cerebellum was exposed and the other above where the base of the sequestrum had rested against the cerebral dura The opening of these spaces was followed by a steady flow of turbid fluid, which laboratory examination showed to be of a character similar to that drawn from the spinal canal. A very extensive dressing of gauze was placed over the wound,

NAME.

F.F. Male Italian - P.G.M.S. & H.

DISEASE

1908.... DATES OF OBSERVATIONS.

DEC.	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10
Cent. / Fahr.	AM · PM	AM · PM	AM · PM	AM · PM	AM · PM	AM · PM	AM · PM	AM · PM	AM · PM	AM · PM	AM · PM	AM · PM	AM · PM	AM · PM	AM · PM	AM · PM	AM · PM	AM · PM	AM · PM	AM · PM	AM · PM	AM · PM	AM · PM	AM · PM	AM · PM	AM · PM	AM · PM	AM · PM
Pulse per minute.	110 / 112	96 / 120	104 / 136	96 / 112	120 / 132	120 / 132	104 / 120	116 / 128	112 / 112	112 / 108	112 / 116	100 / 120	120 / 124	116 / 112	92 / 120	128 / 128	116 / 120	112 / 112	112 / 116	128 / 128	92 / 120	116 / 112	104 / 120	120 / 124	104 / 120	116 / 116	110 / 116	120 / 120
Respirations per minute.	28 / 32	25 / 32	36 / 32	28 / 32	36 / 26	28 / 36	28 / 32	36 / 36	28 / 22	22 / 32	28 / 28	28 / 28	28 / 32	32 / 32	32 / 30	24 / 28	24 / 32	28 / 32	28 / 32	24 / 28	28 / 32	28 / 28	32 / 32	34 / 32	32 / 28	28 / 34	28 / 24	24 / 24
Urine: Qts. / Spec. Grav.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Operation

Sinus Operation 38 c.c.

Lumbar Puncture 26 c.c.

18 c.c.

4 c.c.

Sub-arachnoid Drainage

and in three hours it was saturated. For the next three days the amount of fluid coming from these spaces that were drained was simply enormous. The dressings required to be changed every four to six hours. On the second day following the sub-arachnoid drainage, the mental as well as the general condition began to improve and there were no more periods of coma.

The child was able to take nourishment by mouth and there was a steady improvement in every way. The drain from the cerebellum was removed on the sixth day, and the one above, on the eighth. Twelve days later the posterior wound was closed, primary union being obtained, except at the lower part, which closed a few days later by granulation. At the present writing the child is apparently well except for the facial paralysis, which will, of course, be permanent. The ear is completely dermatized and his mental condition normal.

Having had, during the past three years, four cases of a somewhat similar nature recover when a sub-arachnoid drainage had been done, when, prior to its use no apparent improvement had taken place, we are justified, I believe, in utilizing this method of drainage in an attempt to save what would otherwise prove to be fatal cases. It is important to drain early, before our cases show evidence of such profound sepsis that the system fails to respond to the mechanical aid of the surgeon.

Discussion.

Dr. F. L. Jack, Boston:—Exhibited a drawing of a similar sequestrum, in which case there was no meningitis.

Dr. Geo. E. Shambaugh, Chicago:—Does Dr. McKernon feel that this sequestrum of the labyrinth would possibly have loosened up of itself later on; and, was the subsequent meningitis attributable to that?

Dr. McKernon:—The child had active meningitis before we operated.

Dr. B. A. Randall, Philadelphia:—Some years ago I reported a case of traumatic exfoliation of this kind and on searching the literature I found only 50 cases in adults and only some 56 or more juvenile. I am sure there must have been many not reported and I am glad that these cases have been put on record as it is valuable to have data of this sort.

Dr. James F. McKernon, New York, (closing remarks):—The cases in which I had tried this method of drainage before that were unsuccessful, I believe, on account of inability to get the drain properly introduced. I use the catgut wrapped in Cargyle membrane and have used it since in draining one of the lateral ventricles with a perfect result. The former gauze drainage used to obstruct the opening but it is a very easy matter with this flattened drain (and you can put in more than one if you wish) to obtain perfect drainage, because the tissues do not come down on it and cause obliteration of the space as they do with a wick or tube. These cases ordinarily, so far as I have been able to judge from the literature and my own observations of the cases of purulent meningitis, result fatally, and if we can in any way save a few of them I think it shows a decided advance in this work, I would urge most strongly early exposure and drainage.

Dr. Norval H. Pierce:—How far do you allow the drain to project?

Dr. McKernon:—I have it come out about three inches from the wound.

The Society extended a vote of thanks to the Boston colleagues, and to the President particularly, for the entertainment given.

THE IMPORTANCE OF THE THOROUGH STUDY OF THE NASOPHARYNX IN THE TREATMENT OF DISEASES OF THE EAR.

By FRANCIS R. PACKARD, M. D., Philadelphia, Pa.

Although before a gathering such as this, it may seem somewhat trite to present a paper with the title borne by mine, I feel that the subject is one of great importance and presents some aspects which are possibly not sufficiently dwelt upon, and that, therefore, it would not be amiss to thresh over again some points with which possibly familiarity has bred contempt. There is a saying which has well nigh become a proverb amongst aurists and has been attributed to various distinguished laryngologists in the United States that, "some day the rhinologist will do away altogether with the necessity for the aurist," meaning thereby to imply the great frequency with which affections of the ear depend upon diseases of the upper respiratory tract.

The point I would particularly emphasize, is the necessity for a thorough examination of the nasopharynx before undertaking the treatment of any aural condition. It seems to me that this examination is much too frequently either altogether neglected, or carried on in such a manner as to be practically useless. In teaching in a post-graduate institution, I have frequently been struck with the fact that the physician-student in the aural clinic, who has been told repeatedly to make an examination of the nasopharynx in every case of ear trouble, considers that he has carried out his directions when he has inserted the tongue depressor in the patient's mouth and examined what is revealed in that manner. As Politzer says in his text-book,—"Often, however, without the slightest visible changes on the posterior pharyngeal wall, affections of the mucous membrane of the

nasopharynx may nevertheless be found, which are very far advanced. The absence of changes on the posterior pharyngeal wall does not, therefore, render the examination of the postnasal space unnecessary.''

Among some of the pathological conditions in the nasopharynx exclusive of the infectious diseases which may give rise to disease of the ear are:—

1. The presence of adenoid growths in the nasopharynx which may act either as a mechanical obstruction, interfering with the ventilation of the eustachian tubes, or as a source of infection to the middle ear because, as is well known, practically every adenoid mass is inhabited by numerous pathogenic micro-organisms which, under favorable circumstances, find easy access to the middle ear through the eustachian tube. Every aurist must be familiar with the frequency with which chronic suppuration of the middle ear completely ceases, after the removal of a mass of adenoid tissue from the nasopharynx. This has occurred so frequently in my own work that it has become an automatic process with me to at once turn to the nasopharynx as a possible source for the continuation of a chronic discharge from the ear in almost every instance. I believe that in very many of these cases such nasopharyngeal examination is neglected, and the attention of the aurist is devoted almost solely to finding the origin of the trouble in some local condition within the ear, such as the presence of dead bone or suppuration within the mastoid.

2. So-called catarrhal infections of the nasopharynx are frequently a source of disease of the middle ear, chiefly by the mechanical occlusion of the eustachian tube which results from a swollen mucous membrane. Personally I feel that, in most instances, so-called nasopharyngeal catarrh is generally the result of some more serious condition in the nose or its accessory sinuses, especially the sphenoid, but the term ''nasopharyngeal catarrh'' is probably firmly fixed in rhinological literature, whether it is used to express a distinct entity, or to signify the condition of the mucous mem-

brane of the nasopharynx as the result of disease elsewhere in the nose or accessory sinuses.

3. The atrophic condition of the mucous membrane of the nasopharynx which is usually seen in association with chronic atrophic rhinitis, leads to the accumulation of decomposing crusts in the nasopharynx, and as under these circumstances the orifices of the eustachian tubes are more patulous than normal, it is quite common to see disease of the middle ear result from the patient's blowing or washing infective material into the tubes.

4. Tumors, other than adenoid growths, may occur in the nasopharynx. The author has personally seen a case in which a sarcoma protruded into the nasopharynx from the sphenoid region, first manifesting itself by aural symptoms, the patient complaining of increasing hardness of hearing and tinnitus.

5. The occurrence of adhesions in the nasopharynx, generally the result of previous operative work, is I believe a not uncommon and a frequently unlooked for source of disease of the eustachian tubes and middle ear. Dr. J. W. Jervey, of Greenville, S. C., in a paper read before the South Carolina Medical Society, in 1906, and published in its Transactions, called attention to the frequency with which adhesions in the nasopharynx were sources of pathological conditions in the eustachian tubes and ear. Dr. Jervey stated that he had had his attention called to the subject by Dr. Brunk of Birmingham, Alabama, and Dr. Pynchon, of Chicago. He reported a series of cases, all of which had been greatly improved by breaking up adhesions in the nasopharynx. Shortly after reading Dr. Jervey's paper, I had the opportunity of seeing a patient who had been under his care and had been treated by him, in whom he had broken up a number of adhesions which occluded her eustachian tube orifices. This young woman was the daughter of one physician, and the sister of another. She had had an adenoid growth removed from her nasopharynx and her tonsils taken out in childhood. Some years after the operation she

began to notice that her hearing was impaired and that she also suffered from increasing tinnitus. She was placed by her father and brother under the care of a distinguished aurist, and after his death was treated by several others. Her condition not improving, she went abroad, where she consulted aurists in several cities. Returning to this country, she went for the winter to Greenville, S. C., at which time Dr. Jervey saw her. He proceeded to destroy the adhesions which he found in her nasopharynx, by inserting his index finger and forcibly breaking up the bands with the most gratifying results. Upon her return to Philadelphia, in the early Spring of 1908, I saw her professionally for the first time. I had been a friend of her brother's and had known her and been aware of how very great was the deafness from which she suffered, although I had never treated her. When she entered my office, I was struck with the great improvement which was immediately apparent in her hearing for ordinary conversation. I examined her nasopharynx and found it was quite free from any evidence of adhesions or any other abnormal conditions. She volunteered the statement to me that she had had absolutely no relief from the usual measures of treatment which had been employed in various hands, until a careful examination of her nasopharynx had been made and the adhesions within it had been destroyed. From that time she said her hearing had shown progressive improvement. Dr. Jervey has since published[1] an article in which he gives further details as to his method of work and its results. He also appends to his article, a bibliography of the subject.

Since my attention was drawn to the subject by Dr. Jervey's publications, I have had the opportunity of studying a number of cases in which ear trouble undoubtedly originated from the existence of adhesions in the fossa of Rosenmueller and the nasopharynx, the breaking up of which resulted in a gratifying improvement in the aural condition. These cases presented almost identical histories,

1—Journal of the American Medical Association, May 16, 1908.

namely, prolonged eustachian and middle ear trouble, with increasing deafness, without relief from usual measures of treatment by Politzerization, massage, hot air, etc. Several of these cases had had adenoid operations in childhood. The method I pursued in the treatment was identical with that of Dr. Jervey, namely after the nasopharynx is thoroughly cleansed and cocainized, the index finger of the right hand is introduced and the adhesions forcibly torn across, after which silver nitrate solution or a solution of albuminate of silver is applied over the torn surfaces.

From the observations which are recorded above, we may draw the following conclusions:

1. That in every case of middle ear disease which presents itself for treatment, one of the most important measures to be employed is to make a thorough examination of the nasopharynx.

2. The examination of the nasopharynx should be made, not only with the mirror, but with the finger. The examination should be made, first, before cleansing the nasopharynx, and again after cleansing it. If the nasopharynx is examined while it is full of mucus or other discharges, important alterations within it may be concealed. On the other hand, a visual examination should be made, or at any rate be attempted before cleansing it out, in order that we may ascertain whether there are accumulations of discharge or morbid materials within it. In the case of children or adults in whom it is impossible to use the mirror, the nasopharynx should be cocainized through the nares and a digital examination made. The digital examination of the nasopharynx is, as a rule, so much disliked by patients, that the rhinologist is very apt to neglect it. Of its great value, however, there is no doubt, and I believe it should be made the routine practice in every case in which it is not possible to get a thorough view with the mirror.

3. Although the presence of obvious growths, such as tumors or adenoids, or the existence of inflammatory conditions in the nasopharynx, have had the importance of their

presence as a source of aural disease recognized for many years, the existence of adhesions in the nasopharynx as a cause of pathological conditions within the ear, has been largely overlooked, chiefly because of the difficulty attendant upon the examination of the nasopharynx which would lead to the discovery of their presence.

As my apology in presenting the foregoing remarks on a subject which must be regarded as somewhat commonplace by the majority of my hearers, I would state that my reason for doing so is that it seems to me that in most of the text books, and on the part of some of the teachers in our medical schools, there is a noticeable laxity in directing the students' attention to the importance of a nasopharyngeal examination in the proper study of diseases of the ear.

CHRONIC EPIPHARYNGEAL PERIADENITIS IN ADULTS.

By JAMES E. LOGAN, M. D., Kansas City, Mo.

As its name implies this is a disease of the tissues situated in the vault of the pharynx. The writer is not content with the term periadenitis—as interpreted literally it would indicate that the structures surrounding the glands are alone involved. While it is intended to comprehend a pathological process extending throughout the glandular, muscular, vascular and connective tissues.

In 1903 I read before this association a paper entitled "Adenoid Growths with Special Reference to Adult Condition," in which I recited my experience in operating upon sixty-five cases of adults over twenty-five years of age. I shall attempt to give you further proof of the importance of recognizing this as a distinct disease deserving a separate classification along with other inflammatory processes of the upper respiratory tract. Writers upon this subject have generally considered this condition as an extension of inflammatory processes either from the nose or from the pharynx into the naso-pharynx, making this a secondary and not a primary affection. In the light of our experience we are convinced that in these structures are developed the etiology and pathology of many diseases which have baffled the efforts of our greatest men in the sphere of investigative research. We have been taught to believe that after the age of puberty has passed the lymphatic glands undergo atrophy and ultimately disappear, and clinical facts bear out the fact of this statement within certain limitations. Whenever the age of childhood has passed without establishing pathologic processes of a chronic nature within these structures then, trophic changes take place that very soon obliterate their

existence. But whenever chronic inflammations once become installed they seldom, if ever, disappear. In entering upon the discussion of the pathology of this disease we shall not attempt to go into the details of the acute forms of this affection, leaving that to some future time, fearing lest we may weary you with what may yet develop to be a strain upon your patience.

In 1868 Luschka described indefinitely a chronic disease of the naso-pharyngeal bursa, to which he gave the name "Chronic Naso-Pharyngeal Bursitis." Later in 1885 Thornwaldt gave a more detailed account of this affection, to which our text-books have ascribed the name "Thornwaldt's Disease." D. Braden Kyle refers to it in the last edition of his work as a suppuration of rare occurrence in the pharyngeal bursa, presenting symptoms very similar to those of empyema of the sphenoidal sinus—the latter condition he regards the more frequent. Ballenger mentions it as a disease of the recessus medius due to inflammatory adhesions of the medium borders of the adenoid mass. Schwabach regarded it as a disease of congenital origin situated in the remnant of the middle cleft.

In determining the actual pathology of this disease I have submitted a number of these growths to my friend Dr. Frank J. Hall, of my city, who has spent much time investigating its characteristics and I am indebted to him for valuable aid—I shall give you his report at length—"The tissue removed from the epipharyngeal region of Mr. D. by you and sent to me for miscroscopic examination and description presents the following: "The gross specimen is roughly circular, one inch in diameter, and three-eighths inch thick, sections made at right angles to the surface presents the following: The epithelial covering is squamous epithelium which is broken at one point by an ulcer whose floor is composed of polymorphonuclear leucocytes held in a reticulum of fibrine. At one other point the surface epithelium is being invaded by leucocytes and round cells.

This area lies directly over a lymphoid deposit resembling tonsillar tissue.

"Beneath the epithelium at all points the submucosa is liberally infiltrated with round and polymorphonuclear cell exudate. Here and there is a deposit of lymphoid tissue whose lymph sinuses are choked with inflammatory products. Deeper down groups of mucous glands are encountered. The lumina of these glands are wide and filled with a liberal amount of secretion. About the glands just mentioned are liberal deposits of inflammatory round cells of the plasma of the small leucocyte type. In the planes of connective tissue at the level of the mucous glands is a noticeable amount of fibrine almost sufficient to constitute a severance of the overlying submucosa from the gland bearing area. Still deeper, planes of voluntary muscles are encountered. Between the individual fibres of the muscles is a great quantity of inflammatory material, both cellular and fibrinous, constituting a real interstitial myostitis.

"Throughout all the section and particularly marked in the upper layer of submucosa are many degenerated nuclei of the proper connective tissue. These degenerated nuclei are drawn out in the most bizzara fashion into clubs, strings, etc. No giant cells or other specific histological cell elements or arrangements of same are noticeable. Blood vessels are all the seat of thickening of the intima and media."

You will observe from Professor Hall's report that this disease does not alone involve the glandular structure but extends to the muscular vascular and connective tissues. We believe this to be of especial importance with reference to the muscles concerned in the function of hearing. The tensor tympani, tensor paliti and the levator palati are to be mostly considered in this connection because of their attachments into and around the orifice of the tube, influencing as they do the action of the drum membrane, together with the effect upon the lumen of the tube by the opening and closing functions of the levator and tensor palati.

These muscles originate in and around the orifice and any inflammatory process in adjacent tissue undoubtedly involves these fibres and must of necessity interfere with their physiological action. **This might serve to explain the yet unsettled theories of sclerosis of the middle ear.** Chronic catarrhal inflammation of the middle ear has been the bugbear of every pathologist. He has never been able to establish its identity. We know that these cases progressively increase in deafness even when they are given the very best attention. In the light of these facts it is already evident that either these conditions are irremediable or the etiology, pathology and its elimination are yet unknown. Buck in his third revised edition p. 41, says: "As yet we are unable to form any very accurate idea of the extent to which the impaired hearing in this class of cases (referring to Chronic Catarrhal Deafness) is to be attributed to the abrogation of the functions of the tensor tympani and stapedius muscles. The sclerosing process undoubtedly invades both of them and to a greater or less extent paralyses their action; and it is also conceivable that in certain cases a state of permanent contracture may be produced whereby the membrania tympani on the one hand and the stapedio-vestibular-annular ligament on the other, are kept by these muscles permanently in an abnormal state of tension."

Retraction of the membrana tympani is more often dependent upon the lack of resiliency of the tensor tympani than upon any perceptible encroachment upon the lumen of the tube. This fact can be proven in a large proportion of cases by catheterization. It can also be proven by the unimpeded introduction of the bougie through the tube. If the tube permits of the entrance of the air and also of the introduction of the bougie then why does the membrana tympani remain retracted? The answer to this question seems to me to be found in the foregoing statement, viz: the lack of the resiliency of the tensor tympani. Admitting that sclerosis (a process hard to define) does become established within the drum then it must have a cause, and that

cause in a great majority of cases is to be found in a diseased condition of the epipharynx. This disease may exist indefinitely without producing any disturbance in the function of the ear though this is the most frequent complication.

Whenever the tissue in the vault has been the seat of repeated attacks of acute inflammation, supervening upon the chronic process, we have found thin patients frequent victims of acute Rhinitis and of epidemic influenza. The reason of this lies in the productiveness of this soil for the cultivation of all forms of pathogenic bacteria. In forty-two cases of acute epidemic influenza in adults in which were found the catarrhalis, every one exhibited a greater or less amount of lymphoid and connective tissue hypertrophy in the vault. I desire to lay especial stress upon the question of the amount of this hypertrophied tissue. In my experience the smallest amount of it is sufficient to furnish a field for the cultivation of infectious material.

We must realize that in adults the process of deterioration of this lymphoid structure can leave but a little of the growth in all but exceptionable cases, but the point we wish to bring out is that even the slightest amount may be the origin of wide spread invasion. In the drawings presented for your inspection you will observe that in the cases of No. 1 and No. 2 as shown on the plates, there existed the smallest possible amount of hypertrophied tissue, yet the removal of it brought about good results. In the cases of No. 3 and No. 5 it is our purpose to show that the presence of this periadenitis was the determining pathological process of the chronic suppurative otitis media. The case of No. 4 is of especial interest showing the effect of bacterial invasion into the right ear during measles in childhood and the development of a chronic progressive deafness in the left ear at the age of twenty-eight.

Diagnosis.

Diagnosis of this disease is a matter of little difficulty. In the routine of all nasal, aural and pharyngeal examination

we carefully inspect the vault in every instance. With the rhinoscopic mirror we can in most cases determine fairly well the condition of the epipharynx but we should always go farther and introduce the finger behind the soft palate. By this means we cannot fail to discover every evidence of adventitious tissue in this space. I have presented the plate marked "Gross Section" in order to show that this upholstered mass may exist in considerable thickness without destroying the symmetry of the cavity.

The obtuseness of the angle made at the juncture of the basilar process with the spinal column varies greatly in different skulls, consequently the mirror alone may lead to mistaken idea of the amount, while the keen sensibility of a clean finger is a never failing indicator.

Prognosis.

The prognosis in these cases is usually favorable so far as the vault condition is concerned. So far as the disappearance of complications this depends upon what organs and functions are involved, the age of the patient and the amount and character of the impairment. Within the last six years I have operated upon six hundred and fifty-two (652) cases of adenoids, both young and old (in my private practice.) Of this number 368 were below the age of twenty-five years and 284 were from twenty-five to fifty-nine years. Of the 284 adults 162 were males and 122 were females, 167 between the ages of twenty-five and thirty-five; 106 between thirty-five and forty-five and 11 between the ages of forty-five and fifty-nine.

I have seen one case sixty-fours years of age with large epipharyngeal growth but was not allowed to operate. On the 284 adults 210 suffered from chronic progressive deafness in varying degrees of severity; 24 were victims of recurrent attacks of acute and subacute catarrhal otitis media; 17 had chronic suppurative otitis and 33 exhibited no ear complications of any moment. Of the 210 cases of progressive deafness 182 showed noticeable improvement after

operation. This number represents those who faithfully persisted in the after treatment and whose conditions were not so disastrous as to preclude the possibility of some benefit. Twenty cases were of such long standing and of such a character that the after treatment failed to bring about any appreciable improvement. These patients gave marked evidence of internal ear complications; the remaining eight cases were operated upon and little or no after treatment was given.

Of the 24 cases of recurrent acute and sub-acute otitis operated upon 16 have had no recurrence of the discharge and the hearing has been improved; five have had recurrent attacks—in three of these cases I have recently done the preliminary stripping and secondary removal as in the first operation I failed to get rid of the hypertrophies about the orifice of the tubes; three (3) cases were operated upon and I have lost sight of them.

Of the 17 cases of chronic suppuration of the middle ear occurring in adults over twenty-five years of age five (5) have had no recurrence after the removal of the growth in the vault; eight (8) required subsequent curettage of the necrosed tissue of the middle ear and four (4) demanded the radical operation. Of the thirty-three cases operated upon showing no ear complications all of them exhibited symptoms of nasal and epipharyngeal diseases of various kinds. Four (4) were in patients who had recurrent hemorrhagic expectoration without evidences of lung complication and so far have had no return of the trouble. Five (5) cases had active suppurative inflammation in the epipharynx accompanying atrophic rhinitis. Twenty-four (24) were cases of various nasal and pharyngeal conditions where the periadenitis seemed to be the predominant etiological factor. In more than 75% of these cases turbinal hypertrophies were present. Deflections of the septum existed in the usual proportion. Sinus complications were present in twenty-two—a little less than (10%) ten per cent.

In summing up the question of prognosis my experience

leads me to say that whenever a case presents itself exhibiting any disease whatsoever of the nasal or accessory sinuses, the middle ear, the pharynx or larynx, and at the same time there is evidence of the smallest amount of adventitious tissue in the epipharynx the prompt removal of this mass adds greatly to the chances of permanent relief. If I may be pardoned for appearing extreme and over zealous I will go still farther and say that permanent good is practically impossible if this fertile field of infection is not destroyed.

Symptomology.

It is hardly necessary to dwell at length upon the symptoms of this disease as to go into detail would involve the question of complications which are so varied that your patience would cease to be a virtue. Just a few points I desire to bring to your attention. **First**—The general symptoms are those complained of by patients suffering from the ordinary phases of nasal inflammations, viz.—repeated attacks of acute coryza, especially of the infectious influenza type, sensations of fullness in the vault and pharynx and a more or less desire to hawk and expectorate especially upon arising—each morning the patient may remove a large mass of inspissated muco-pus; during the day a large amount of mucus and muco-pus is secreted.

As heretofore stated a very large majority of my cases were coexistent with hypertrophies of the nasal mucosa and in many deflections of the septum were present. Consequent symptoms of these conditions were present. The same may be said of those showing sinus complications.

Secondly—The invaluable aid given us by the mirror enabling us to see the actual conditions and lastly and by all means the most important information revealed by the introduction of the thoroughly sterile finger behind the soft palate—all conspire to render plain the symptoms of this disease.

The treatment of this condition can be nothing less than a total extripation of the diseased tissue. If allowed to re-

main it will suffer repeated invasions of acute inflammations and render ultimate relief, even to the remotest complication, impossible.

Situated as it is high up in the vault and in the fossae on either side, it has been almost impossible to devise an instrument that will serve the purpose of total extripation. Failing in so many instances to remove the tissue in the fossae and about the orifices of the tubes, I have resorted to the following method:

Thoroughly cleanse the epipharynx and the nose with a warm sterile normal salt solution by means of the post-nasal syringe. Through the nose by means of long curved applicators wrapped with cotton apply an 8% or 10% solution of cocaine several times for ten or fifteen minutes—in the intervals of this application I also apply a solution of suprarenal extract about twice through each nostril. Within this time the vault is well anaesthetized. With thoroughly sterile hands—the right index finger with long sharp nail is introduced behind the palate—beginning at the lower border of the left eustachian orifice proceed to break up all the adhesions and upholstered mass within the vault—in other words strip the growth away from its bed wherever it can be felt. The result of this preliminary operation is to free the tubes and the fossae of the resisting mass which is almost impossible to remove by forceps or curette. An active inflammation follows this procedure which renders the tissue brittle and susceptible of easy separation from the underlying structures. After an interval of forty-eight hours the secondary operation is performed—this done by the use of the curette in a large proportion of cases. In well trained throats the Brandagee forceps may serve good purpose. In the selection of the curette I prefer the Beckman pattern. After the operation the finger should be introduced behind the palate to make sure that none of the growth remains. The size of the curette depends upon the width of the space between the tubal orifices—the No. 4 Beckman is the size I usually employ. Another important

point is that the curette should be pushed high into the vault following closely the posterior border of the septum so as to engage the mass—then changing the grasp of the instrument so that the dorsum of the hand is upward, firmly and quickly, with a wrist movement, cut backward and downward following the under surface of the basilar and the anterior surface of the spinal column. This procedure if done with a sharp instrument, will deliver the growth into the mouth—sometimes out into the lap of the patient or upon the gown of the operator. I have performed this operation in this manner more than two hundred times and have not had occasion to use a general anaesthetic. In fact I would hesitate a long time before giving ether or chloroform to an adult—first, because the operator is at a great disadvantage by reason of the lying down position of the patient and secondly, there is much greater danger of hemorrhage.

The advantages of the primary and secondary operations are: 1st. The operator can break up all adhesions easily and strip the mass from its bed in the fossae of Rosenmuller where it exists in greatest abundance. 2nd. This mass cannot be removed in its entirety in these fossae without the greatest difficulty by the use of forceps or curette. 3rd. Your finger will detect hypertrophies where the mirror will fail to reveal them. 4th. The danger of severe hemorrhage is practically eliminated by the preliminary stripping of the mass. This procedure breaks up the continuity of the blood vessels which undergo degeneration within forty-eight hours, at which time the growth is removed. In all of my experience with this method so far have had but three cases of hemorrhage which required plugging.

Case No. 1.

Miss Wharton, age 28, light eyes, brown hair, applied to me for treatment July 9th, 1908. During the winter of 1904 she suffered an attack of double acute catarrhal otitis media which lasted some two or three months. Previous to that time had noticed that her hearing was becoming impaired, especially during attacks of "colds." Since the attack

of double otitis she realized that she was fast losing ground. Being a music teacher, she became greatly alarmed at this condition. Upon testing her ears found watch hearing: Right ear 3 inches and left ear 4 inches. During attacks of acute rhinitis hearing in both ears reduced to bare contact of watch, bone conduction increased—drum membranes of both markedly retracted. Schrapnells membrane showed signs of previous acute inflammations. Catheterization showed both tubes open and the bougie passed readily into the middle ear.

Examination of nose revealed slight hypertrophies of both turbinals—the epipharynx was the seat of some thickening in and about the orifices of both tubes—the left posterior lip bound down with three bands of adhesions to the posterior border of the fossae of Rosenmuller—only one small adhesion on right. As represented in the plate you will observe that there showed but little evidence of thickening except in the two fossae. With the finger I detected great depth to the fossae which was filled to almost a level of the grooves with a mass of tissue. This mass was not observable through the mirror and would have been overlooked but for the use of the finger.

Diagnosis.

Chronic Epipharyngeal Periadenitis with progressive catarrhal deafness.

During the after treatment she complained of great discomfort from what she termed her ears "clicking." This symptom has partially disappeared. This "clicking" sensation I regard as an interference with the free action of the tensor tympani, levator and tensor palati muscles rather than the interrupted entrance and exit of air.

Am reporting this case to illustrate the facts (1) The mirror alone did not reveal the true condition of the epipharynx; (2) Air passed readily into the middle ear, yet the drum membrane remained constantly retracted. The bougie passed both tubes unobstructed.

Case No. 2.

Mrs. W. H. Jones, age 54, married, one grown daughter. Applied for treatment February 27, 1906. Gave history of progressive deafness of more than thirty years standing—had been treated more or less constantly for thirty years. Right ear the seat of recurrent acute otitis in childhood. Left ear had never been involved in any acute inflammations. Hearing tests: Watch at contact in right ear, at bare contact in left. Bone conduction increased in left—tuning fork on vertex forehead or teeth intensified in left—indefinite in right. Whisper heard in left at two inches—not at all in right. Drum membrane in right showed many scars and was deeply retracted—ossicles displaced high up in attic and bound by adhesions. Left drum membrane slightly thickened—above firmly retracted—lower portion normal in color.

Examination of the nose revealed turbinal hypertrophies of both inferior bodies. The epipharynx exhibited the picture showed in plate No. 2. I could see but a slight ridge on left side extending from the basilar down the posterior wall blending with some hypertrophied tissue which began with the upper portion of the fossae of Rosenmuller and disappeared under the posterior eustachian lip of that tube. The right fossae of Rosenmuller was more nearly filled with a mass of larger size—one small adhesion on left side. The finger confirmed the presence of a mass greater than the mirror showed. This patient complained of much annoyance from the "clicking" sensation in left ear; she complained of very occasional tinnitus.

Diagnosis.

Chronic Epipharyngeal Periadenitis—fixation of tensor tympani and probable ossicular anchylosis in right ear. Partial fixation of tensor tympani and palati muscles in left ear and vault.

This was a most unpromising case. The patient talked in such low voice as to be almost inaudible. She observed the

movement of the lips in those conversing with her very closely.

Prognosis.

Very unfavorable so far as the hearing was concerned. I removed a mass of considerable size from the vault on March 25, 1906. She remained under my charge constantly for more than a year, during which time I catheterized both tubes and introduced bougies twice each week. She persistently complained of the "clicking" in left ear, which even now occasionally troubles her. She called on me May 27, 1909, at which time I found the following conditions: Hearing, right ear ½ inch; left ear, 2 inches; whisper test 6 feet; no tinnitus; hears ordinary conversation at 8 feet distinctly.

Case No. 3.

Mrs. Brueggen, age 34, German parentage, married, one child; light blue eyes, brown hair, strong, robust. Applied to me for treatment November 15, 1905. Had measles at seventeen years of age followed by a suppurative otitis media in left ear that had never ceased discharging in seventeen years. At the time of my examination found left ear excreting a very foul pus in great quantity. A large perforation including almost the entire Schrapnells membrane, the tip of the handle of the malleus was yet intact below the margin of the opening; incus was destroyed; large granulations protruding through opening. Mastoid had been involved according to patient's statement; but no evidence of trouble at the time of her visit to me. Patient heard watch—left ear at bare contact when first examined; right ear normal.

Examination of nose and epipharynx showed the presence of extensive inflammations. The vault was upholstered with a mass of hypertrophied tissue which under the microscope proved to be an inflammation of the muscular, vascular and lymphoid structures.

This seemed a fit case for radical operation though I felt warranted in postponing such action until the growth in the vault was removed and the granulations in the ears destroyed. I operated upon her November 20, 1905, removing the growth. Ten days later curetted out the granulations through the perforation in drum membrane—packed the canal with iodoform gauze. This treatment continued for three weeks after which time the discharge ceased and has not again recurred.

This case with that of No. 5 are exhibited here for the purpose of showing some of the different phases into which this periadenitis enters as determining etiological factor.

Case No. 4.

A. J. Dawson, age 28, single, clerk in dry goods store, dark eyes and hair, not robust, pale and anaemic. Applied to me for treatment January 27, 1909, threatened with attack of acute otitis in left ear—severe pains in ear—some temperature, etc. This condition lasted but a few days, then subsided.

Examination of this case showed right ear had been seat of suppurative otitis in childhood, following measles; almost total destruction of drum membrane and contents of middle ear. At present only slight discharge. Hearing—right ear Nil. Left ear soon regained its normal condition so far as any inflammatory process was concerned. The function, however, had been long since impaired. This loss of hearing became noticeable at about eighteen years of age. Following this acute attack for which he visited me, left ear showed watch at bare contact which improved to three inches when all acute symptoms subsided. Membrana tympani firmly retracted—some evidence of thickening.

Examination of nose showed prominent inferior turbinals—septal deflection to left side. Epipharynx showed condition shown in plate No. 4. This patient was operated upon March 29th, after a preliminary stripping done on the 27th. The growth removed was typical of periadenitis and is the last one examined by Dr. Hall, whose report I have submitted to you.

Case No. 5.

Mrs. Gilliam, age 28, light hair, blue eyes, anaemic, weight 105 pounds, family history good. At 12 years of age patient suffered an attack of scarlet fever. Right ear became seat of a destructive suppurative otitis media which continued uninterruptedly for 15 years. Received treatment of various kinds with no permanent results up to the time of coming to me. Upon examination of the right ear found hearing completely destroyed, a very offensive discharge of pus not great in quantity—discharge consisting of pus with much desquamation, epithelial cells becoming inspisated about the walls of external canal. The drum membrane exhibited a large perforation, including the entire posterior superior quadrant. Schrapnells' membrane the seat of great inflammation extending high into the attic—the incus had been destroyed but the malleus and the stapes remained—granulation tissue protruded through the perforation in the drum membrane. During acute attacks some tenderness and swelling appeared over mastoid; but none was present at the time of her visit to me.

Upon examination of her throat I found an inflammatory thickening of the lining of the vault—in the fossae of Rosenmuller on both sides could be seen a considerable mass of hypertrophied tissue enough to almost obliterate the folds surrounding the tubes—the right mass being much more distinct. Thick adhesive bands extending from the pharyngeal wall to the posterior eustachian lips. The lip of the right tube was very much enlarged—there was little or no hypertrophy in the middle of the vault. The entire surface was covered with a thick muco-purulent secretion and could be seen from the crevices between the folds of hypertrophied tissues. The nasal mucous membrane was greatly thickened, especially over both inferior turbinates and a cartilaginous deflection of the septum to the right side of slight degree.

This seemed to me a very unfavorable case and so informed the patient, telling her that I regarded a radical

operation necessary to a complete recovery. To this she demurred. On July 9th, 1908, I did the preliminary operation of stripping the vault tissue and on the 11th removed the mass exhibited to you. This patient made a rapid recovery—the discharge ceased in twenty-one days after the operation and up to the present time there has been no recurrence.

REPORT OF A CASE. REMOVAL OF A FOREIGN BODY FROM THE REGION OF THE TYMPANIC CAVITY; ENTRANCE THROUGH THE SOFT PALATE.

By D. HAROLD WALKER, M. D., Boston, Mass.

Mr. President and Members:—I beg to report this case of accident and injury to the throat and ear because of its rarity and for the reason that no permanent injury resulted.

On the thirty-first of last July, a four-year-old boy was swinging in a hammock, sucking what is known as a "molly-coddle," which consists of a lump of taffy on the end of a pine stick about four inches long and smaller than a lead pencil in diameter. He was suddenly thrown out of the hammock, and with such force, that the stick was driven into the tissue just back of the last molar tooth on the left side. The person who removed it, remarked that it required a great deal of strength to pull it out. There was but little bleeding. For the next two days, the boy was quite comfortable, but his mouth was sore and he opened it with difficulty. Later he complained of his face paining him and a swelling appeared in front of the auricle. The ear began to discharge and the pain ceased. The mouth wound soon healed, but the discharge continued from the ear. During the month of August, he would complain of pain in front of the auricle, and finally he caught cold, when the cervical glands on both sides of his neck became swollen, so much so that he could not lift his head without help. At this time, six weeks after the accident, he was taken to an aural clinic, and the mother was told that there were no signs of the injury in the throat, and a diagnosis of "acute suppurative inflammation of the middle ear with cervical adenitis" was made. Conditions remained the same until October third, nine weeks after the accident, when a swelling occurred under and behind the auricle, which soon burst.

This discharge was very offensive. He was taken to the Children's Hospital, where I saw him. The general condition of the child was good. Upon examination of the left ear, the canal was found to be full of pus and granulation tissue, therefore it was impossible to see the drum membrane. Bare bone was felt in the middle ear and on the floor of the canal. Behind and below the auricle was a tumor the size of a chestnut; which was tender when touched. The child was etherized and the granulation tissue removed from the canal. In its depths a rough surface was felt and finally a piece of wood an inch long and half the diameter of the stick, was removed. So much bleeding ensued, that I could get no definite views of the canal or middle ear. The tumor was incised and the pus evacuated. A sinus was found leading from the cavity downwards and inwards along the Eustachian tube, for a distance of two inches. The end of a probe passed into the sinus could not be felt in the throat. A connecting sinus lead through the wall of this sinus into the external auditory meatus. The wound was curretted and dressed. For two weeks the wound and the canal continued to discharge, and the condition had not improved. Ether was given again and the sinus laid open and the cavity thoroughly investigated. A second piece of wood, evidently the other half of the portion removed previously, was removed from a position under the external auditory meatus, and about one inch from the surface. Another curretting was done and within a few days the cavity closed up. The discharge continued from the canal for several weeks, but finally ceased. At the present time the canal is of normal size, the tympanic membrane is healed and the hearing is practically normal.

It seems quite remarkable that a piece of wood of that size would penetrate so deeply, splinter, and yet do no injury to such important structures as the facial nerve and the carotoid artery. Whether the tympanic cavity was entered, it is impossible to say, but it was probably infected from the contiguous inflammation.

RADICAL REMOVAL OF THE TONSIL.*

By CHARLES W. RICHARDSON, Washington, D. C.

During the past few years the radical element in tonsillar operations has taught one valuable point to the whole profession, and that is that our previous methods at removal of tonsils through the use of tonsillotomes and other cutting instruments was incomplete, and, in many cases, insufficient and unsatisfactory. The reason that this point went so quickly "home" and gained so many adherents is doubtless due to the fact that many of the workers in this field had had cause to be dissatisfied with many of their previous apparent complete removals, and were ready to accept the thorough and complete removal of tonsil and capsule when its practicability was demonstrated. A large part of the conservative element still stands aghast at that further postulate of the radical element of the laryngologists who consider every tonsil a foreign entity in the throat and proceed to attempt to remove it, however microscopic it may appear. Every community has now within its doors one or more of these tonsillar phobists, to whom the mere sight of a tonsil, however innocent it may appear and however unconscious the patient may even have been of its existence, is an abnormality to be as urgently removed as though it were a sarcoma or other malignant growth. When a tonsil is diseased, or is the subject of frequent inflammations or hypertrophy, it should be removed. I consider it radically wrong to remove a tonsil that is not enlarged and that has never given rise to any disturbance within its own borders or elsewhere.

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*Read by title.

Within the past four years radicalism in the removal of the tonsils has become more insistent, and numerous are the methods by which this radical removal is attained. The essential feature sought for in the radical removal is, the complete enucleation of the tonsillar mass. It is not my intention in this paper to enumerate the various procedures which have been suggested by many operators to accomplish this result, as it would make my paper too tedious, but simply to describe that method which I have found to be the most satisfactory, the easiest to perform, and which gives uniformly perfect results. For some years past I removed the tonsil in many cases by tearing it away from its bed with a Myles tonsil punch which failed to bite. This method of removal of the tonsil taught me the fact that, in many cases, the tonsil could be easily separated from its bed, but as, at best, the method employed was a piecemeal operation, it was not at all satisfactory. Also the dread of tearing away more than one desired, when one is working in a field covered with blood, makes this operation one fraught with considerable danger. When Dr. G. L. Richards described his method of completely enucleating the tonsil through the finger dissection, I was prepared, through my former work, to immediately accept it, my mind being free from scepticism as to its practicability and the ease with which it could be performed. I have never been willing to accept it, however, in all its details, as given by Dr. Richards, especially as to the attempt to make it a so-called bloodless operation through the use of peroxide of hydrogen. This use of peroxide of hydrogen to stop the moderate hemorrhage that takes place is, to my mind, the only dangerous feature in the original technique. The operation, as so well described by Dr. Richards, requires only as instruments, a mouth gag and a pair of grasping forceps. None of the forceps I have yet seen are to my liking. Most of the grasping forceps have sharp hooks, which are dangerous, and always tear out when traction is employed, they

universally lock badly, and the handles are unsatisfactory. A good hamostat answers the purpose admirably, for with it the more or less completely separated tonsil can be grasped firmly, and will not tear out when moderate traction is employed. The method employed is, after the patient is anaesthetized and the mouth gag is in place, to introduce the nail of the index finger between the anterior fold and the body of the tonsil, gradually working between the two with the nail, until there is imparted the sensation of the breaking away of the mucous membrane which binds them together. I then most frequently separate the tonsil throughout the middle, the separation usually being fairly easy, and then push upward, separating it throughout above. After this is attained the tonsil usually falls forward and the lower portion is peeled away by making pressure from above downward with the finger. At other times I make my anterior separation along the whole anterior border and then starting from above gradually peel the tonsil out by working from above downward. The tonsil is now grasped by forceps, and, while slight traction is made, the remaining fibers are separated from the mass with the index finger. Careful inspection should be made after the removal to ascertain if small fragments are left behind either at the superior or inferior commissure. I find my Myles' non-biting tonsillar forceps are admirable for removing these small masses. The hemorrhage is not very great, it always subsides with the cessation of the operation, and I have never had a post operative or secondary bleeding. The period of healing is usually a week and the amount of pain is always very great. The appearance after healing is ideal. A moderate temperature may be maintained until the healing is complete. I have found this method as applicable to adults as to children. In about 95% of cases I have completed the operation solely by this method, in about 5%, on account of tearing the tonsil during the separation, I have been obliged to resort to my old method

of removal. As one becomes more expert, I believe that all tonsils, as they come, may be removed by this method.

This method is simple and rapidly accomplished.

It requires few instruments.

Anyone can become dexterous in its performance.

The tonsil with its capsule intact can be completely enucleated.

There is less danger from hemorrhage than by any other method.

The result is ideal.

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